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An independent non-profit corporation
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ASSOCIATION OF
COMPUTER USERS

Volume 3.2

Dear ACU Member,

Thank you for subscribing to ACU's *BENCHMARK REPORT,* Series #3.

The main value of this series is simply to help you narrow down your choices when considering multiple-user computer systems costing between $25,000 and $50,000. Instead of each member "re-inventing the wheel" and analyzing each system from scratch, our intent is to provide you with valuable comparative information at a price which is far below the cost of doing the research yourself.

Of course, your own needs should dictate which system you ultimately choose, and we are specifically **not** endorsing or recommending any particular vendor or machine. The choice is yours; we only hope to help you by providing the only source of unbiased, user-oriented, benchmark information available today.

Sincerely,

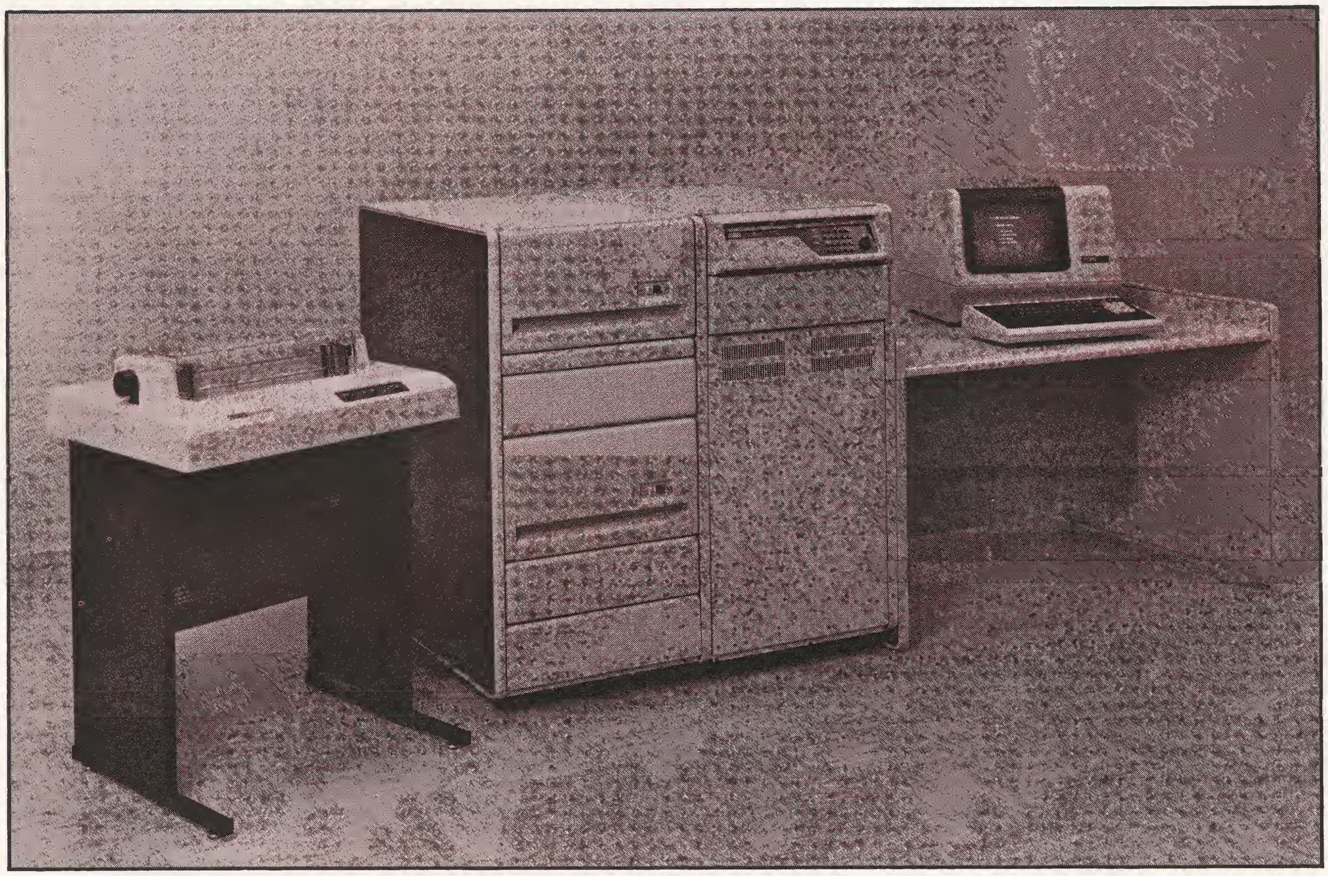
Hillel Segal

Hillel Segal, President

BENCHMARK REPORT

ASSOCIATION OF COMPUTER USERS

VOLUME 3.2, NUMBER 1, AUGUST 1980



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The DEC Datasystem 355

DEC DATASYSTEM 355: BENCHMARK REPORT

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PREFACE

The DEC Datasystem 355 is the first computer to be evaluated in this series of reports covering multi-user computing systems in the $25,000 to $50,000 price range. As the first, it will provide a baseline against which to compare other systems to be evaluated. The goal of this series is to provide users with comparative information on a number of systems for use in selecting from among the many alternatives available--information which is simply unavailable from any other independent source.

In evaluating computing systems, the technical specifications supplied by manufacturers are often difficult to interpret and are seldom comparable across different computers. The potential buyer needs to know how well the equipment performs in specific applications, and how that performance compares with other computing systems. Additionally, subjective factors such as ease of use, versatility, and support service must be considered as a part of the choice process.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

Digital Equipment Corporation's Datasystem 355 as configured for our tests consists of a PDP 11/34A central processor, 256K bytes of central memory (128K is standard), 10.4 megabytes of hard-disk storage, an eight-line multiplexer, a VT100 console terminal, and an LA180 line printer. Priced at $43,550 (three additional VT100 terminals would bring the price to $49,700), our benchmark tests revealed the following:

- The Datasystem 355 is based on the PDP-11, a well-known, time-tested family of DEC processors. The 11/34, used in this system, can support both the CTS300 operating system (which we tested) and the more powerful CTS500 operating system.

- Users were very satisfied with their DEC 11/34 based system. They chose DEC equipment because of the reliability of the hardware. The availability of non-DEC peripherals, at a lower cost, is a decided advantage. Most were using the DIBOL language for at least a part of their programming, and rated the language as easy-to-learn and efficient. Applications included standard accounting and payroll, and technical computing.

- Under the CTS300 operating system, DEC provides their own DIBOL-11 programming language. Combining elements of COBOL and FORTRAN, this language appears highly suitable for business programming applications. Under CTS500, DEC supports COBOL, FORTRAN, and BASIC, in addition to DIBOL.

- Software compatability as a user moves up (or down) in computer hardware capability, is not a problem in the DEC PDP-11 line. Software developed on the smallest of DEC's PDP-11 based computers will run on any computer in the line, including the 32-bit VAX-11/780.

- Digital is moving in the direction of offering more "end-user" software and application packages, including a general business package. This package is being sold to DEC's O.E.M.s as well as to end-users themselves. Thus, DEC is among the first of the larger computer manufacturers to move into application software design and support.

As the first system to be tested in this benchmark series, we can only make general comments about the speed of computation. The CPU-intensive program ran in approximately one-half the average time recorded in our benchmark reports on systems costing under $25,000, as did the I/O-intensive program. The order-entry application program did show some degradation in response time as more terminals were added. As we test the eleven other systems to be covered in this series, the comparative ranking of DEC's Datasystem 355 will become apparent.

BENCHMARK REPORT

SYSTEM: DEC Datasystem 355

PRICE AS TESTED: $43,550

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE*	
A-8	N = 3000	38.8 seconds
	I/O INTENSIVE	
B-4	N = 3000	46.7 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	5.0 seconds
D-2	4 terminals	7.3 seconds
D-3	6 terminals	11.9 seconds
D-4	8 terminals	16.5 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program *	Order Entry Program
E-1	2 terminals . . .	44.7 seconds	7.5 seconds
E-2	4 terminals . . .	61.7 seconds	9.3 seconds
E-3	6 terminals . . .	71.8 seconds	13.5 seconds
E-4	8 terminals . . .	84.1 seconds	16.1 seconds

Note: Order Entry Program times represent average processing times per transaction

*Normally, A-4 (a program with square and square root) timings will be reported. The 355 does not have root functions, so A-8 (using only multiplication and division) timings are given.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Digital Equipment Corporation and requested their assistance in benchmarking the DEC Datasystem 355 mini-computer system. We requested that the total system be priced in the $25,000-$50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 limit (as it does in this case), we advised DEC that we would report the cost over-run, but would continue to benchmark the computer using up to eight terminals.

DEC provided us with a Datasystem 355 located at a private user's facility in Denver, Colorado. The system consisted of a PDP-11/34A central processor, 256K bytes (256,000) of central memory, 10.4 megabytes (10.4 million bytes) of hard-disk storage, an eight-line multiplexer, a VT100 Console terminal, and a line printer, for a total price of $43,550. This price includes only one terminal. Since each additional terminal costs $2,050, three additional terminals could be purchased for a total cost under $50,000. In addition, DEC supplied us with programming and other on-site technical support before, during and after the benchmark procedure.

Benchmarking The Datasystem 355

A series of four visits were required to perform the benchmark on the Datasystem 355. On the first visit, communications were easily established between our benchmark driver system (a North Star Horizon computer and drive program) and the DEC computer. The following two sessions involved debugging the order-entry program as run on the DEC system in our benchmark procedure. This debugging/testing process was complicated (and lengthened) by a "bug" in the Datasystem 355's operating system (a version of their CTS300 system that was unreleased at that time). Upon discovery and correction of this bug, the benchmarks were then routinely performed during our fourth visit.

The Benchmark Driver System

Execution of the order-entry system program and all response-time measurements are controlled by our benchmark driver system. This system is composed of a benchmark driver computer, the North Star Horizon, and a benchmark driver program written by our staff. The driver system appears to the test computer (the

DEC) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of one computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, our benchmark driver system also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and 2 reports).

Our Observations

As on nearly all computer systems of this size, it is necessary to "personalize" the Datasystem 355's operating system. This personalization process, often called system generation (sysgen), is done to inform the operating system software of the particular hardware configuration to be used (number of terminals, disks, etc.) and other processing requirements (number of programs that can be run, number of files to be opened, etc.).

The sysgen procedure on the 355 is handled by a sysgen utility program. Over the course of 10 to 15 minutes the user is prompted by the program to enter all the necessary information. The utility then uses this information to assemble the software modules that will be needed in the personalized version of the CTS300 operating system.

The CTS300 operating system is a complete software package that includes the DIBOL-11 programming language, system utilities, a text editor, a sort/merge program, and program development tools. We found this system to be a "standard-approach" operating system. Its line-by-line command structure is common to many operating systems, though we must admit we prefer the increasingly available "menu-driven" approach (the operator is given a list or menu of commands to choose from). The line-by-line structrue of the CTS300 system requires the operator to memorize (or look up) the system commands, a task that should be

easily accomplished after a few days with the system. One capability we did like was the "type-ahead" command feature. This feature (set during system generation) allows the user to type in a command, and while that command is executing, type in several other commands that will then be executed in sequence as previous commands are completed.

The multi-terminal order-entry system which we used in our benchmark test was programmed by DEC personnel in DEC's own DIBOL-11 programming language. During the process of debugging this program we had the opportunity to become acquainted with DIBOL. We found DIBOL to be a useful business programming language which, though we had never programmed with it before, seemed familiar and easy to use. We attributed this familiarity to DIBOL's similarity to COBOL (in its data-definition) and FORTRAN (in its procedural statements).

To run the order entry system with eight terminals, eight copies of the program resided in dynamic partitions (i.e., each had its own "chunk" of memory). Each program occupied about 18K bytes of memory and the operating system took about 40K bytes, leaving about 72K bytes still free for additional programs. This partition method, as opposed to swapping copies of the programs in and out of memory, generally results in faster response times and smaller resident operating systems.

During execution, the order-entry programs running in the 355 all used the same files (invoice, inventory and member files). Printed output was concurrent with the execution of the order-entry programs as opposed to printer output after all terminals had finished. This concurrent output was possible on the 355 due to the availability of SPOOLing (software that allows Simultaneous Peripheral Output Overlap).

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-8	Results:	N = 3000	38.8 seconds

Comment: *This time is for the CPU-intensive program using only multiplication and division. Therefore, this result should be compared to timings for Benchmark Number A-8 (not A-4) in our other series of reports.*

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,275 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,275 reads. The average run-time

on this test for the systems in our Series 2 was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	46.7 seconds

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

Our measurement of performance is terminal response time, the time between an operator pressing a carriage return to end a response and receipt of the first character of the next computer prompt. It is in the interval that the computer is processing information and manipulating files. Thus, we can equate this terminal response time to system processing time. The total accumulated processing time is divided by the total number of transactions to arrive at an average processing time per transaction. It is this average that is reported here.

Order Entry Run in Production Mode

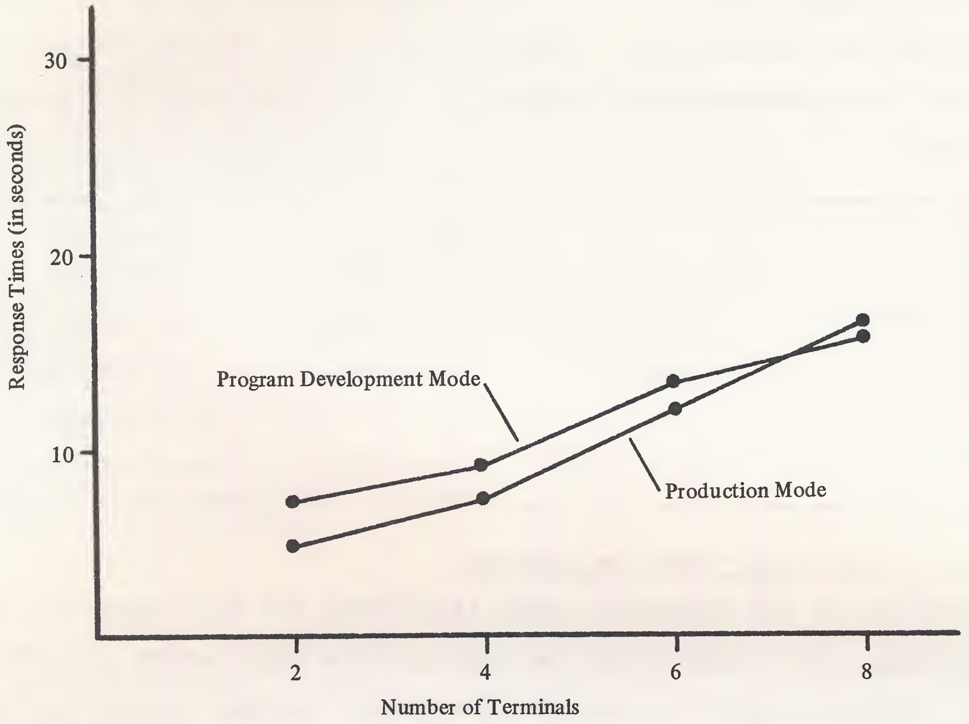
The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	5.0 seconds
D-2		4 terminals	7.3 seconds
D-3		6 terminals	11.9 seconds
D-4		8 terminals	16.5 seconds

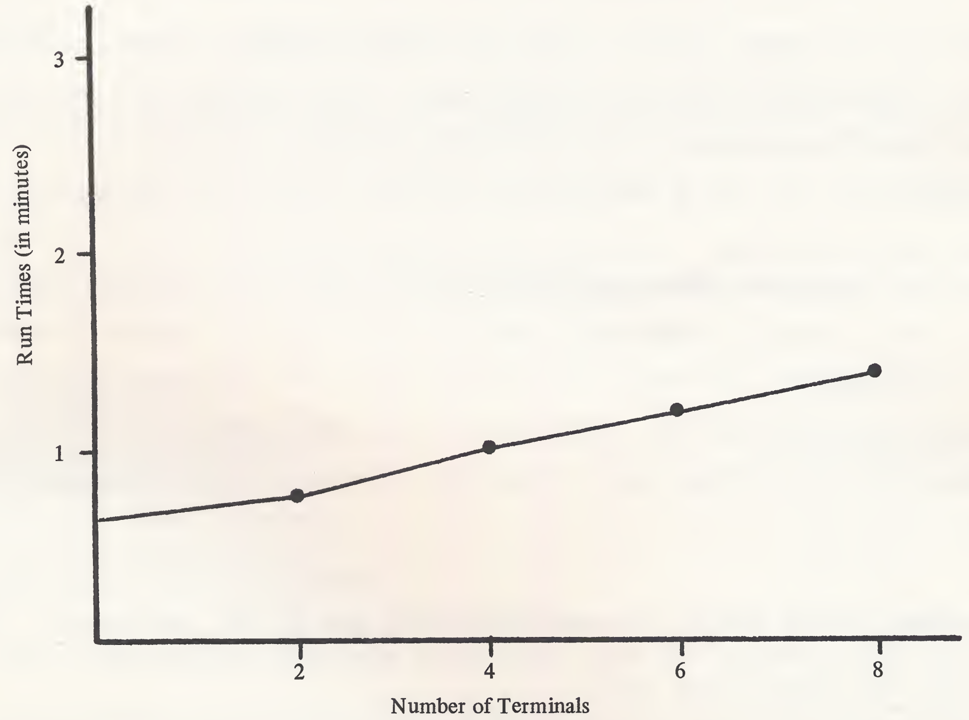
Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	44.7 seconds	7.5 seconds
E-2		4 terminals	61.7 seconds	9.3 seconds
E-3		6 terminals	71.8 seconds	13.5 seconds
E-4		8 terminals	84.1 seconds	16.1 seconds

Analysis of "Real Life" Problem Results

The two graphs on the preceeding page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for 2, 4 6, and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-intensive job.

Note that in all cases, adding terminals slows response times. Moving from 2 to 8 terminals doubles the processing time. Also, adding the background CPU-intensive program increases the order-entry program processing time by 50% for 2 terminals, 27% for 4 terminals, 13% for 6, and -2%* for 8.

We expect the response characteristics exhibited here to be the norm in testing other systems, although some will perform significantly better as well as significantly worse. Of these characteristics, the extent of processing time degradation displayed as the number of terminals increases is the key factor which should be considered when analyzing alternative multiple-user computer systems.

**This anomaly could not be clearly accounted for by DEC personnel. They suggested that perhaps the CPU allocation algorithm might allow this to happen in this particular case.*

SYSTEM AS TESTED: DEC DATASYSTEM 355

Costs

Dual RL01 disk-based DEC Datasystem 355 with LA180 printer		$36,800

- PDP 11/34A CPU
- 128K bytes central memory
- 96 ASCII character set, 132 column, printer and control unit, 180 CPS
- DD11-CK System unit backplane
- Hardware memory management
- Bootstrap loader
- Serial line interface
- Real-time clock
- VT100-NA console terminal with DEC form keys
- RL11-AK disk controller
- (2) RL01-AK 5.2 MB disks
- (2) H9642-AA cabinets
- H9532-AA Datasystem workstation
- QJ354-AQ, CTS300 operating system with services on RL01 media
- DIBOL-11 programming language
- 2 training credits

MS11-LB	128K bytes add-on central memory	$ 4,300
DZ11-A	Asynchronous 8-line multiplexer for EIA/CCITT terminals or lines	$ 2,450
	Total System	$43,550

Our Observations

Additional VT100 terminals cost $2,050.00 each. Staying within the $50,000 upper boundary of our price range, three additional terminals could be purchased.

Configuration	Total Price
System with one terminal	$43,550
System with two terminals	$45,600
System with four terminals	$49,700
System with six terminals	$53,800
System with eight terminals	$57,900

Summary of Equipment and Features

- The Datasystem 355 uses the PDP-11/34A central processor. This processor comes with 128K bytes of central memory in the Datasystem 355 (the processor is byte-addressable and uses 16-bit words).

- Options for the 11/34A processor include a 32K byte add-on memory which costs $2,350 and a 128K byte add-on memory for $4,300. Cache memory, consisting of a 2K byte high-speed random-access memory, is also available for $4,150. Other options include additional expansion space, a battery backup, various cabinets, and so on.

Our Observations

Digital's 11/34A processor is one in a family of PDP-11 processors. This family spans a wide spectrum of computer systems, from micro-computers to medium-scale computers. These processors share a common architecture, with the most outstanding common feature being they all process data on a data bus called the UNIBUS. This commonality among the PDP-11 processors results in software compatability up and down the PDP-11 line. Programs developed on the PDP-11/03 (their smallest) will run with only slight modifications on any other PDP-11 system.

DEC's cache memory reduces the time needed to access frequently used locations in central memory. This is done by using its small amount of memory (2K bytes) to store the contents of those locations fetched from main memory by the processor. When the processor calls for this location again (as is very likely due to the repetitive nature of most programs), the cache memory registers a cache "hit," sends the information to the processor, and thus saves the processor the chore of fetching the information from main memory (a much slower process). DEC indicates that with certain applications, processing speed may be increased by as much as 60 percent using cache memory.

User Comments

. *DEC has state-of-the-art equipment . . . I'd buy it again.*

. *Lot's of people have good hardware . . . the real question is who is going to be in business in a few years. That's why I picked DEC.*

STORAGE DEVICES

Summary of Equipment and Features

- DEC offers a very large assortment of storage devices for its Datasystem 355. For $4,050 each, up to six more 5.2 megabyte cartridge disk drives could be added to the system we tested, raising storage capacity to about 40 megabytes for the system at an additional cost of about $32,000. DEC also offers 10.4 and 28.0 megabyte drives at costs of $5,600 and $11,200, respectively (up to eight may be used). If a user upgrades to the CTS-500 operating system, 67.0 and 176.0 megabyte drives become available at costs of $19,300 and $35,000 (up to eight may be used).

- DEC also offers magnetic tape transports that record at 800 or 1600 bits per inch on 9-track tape. The first transport costs $20,200 and subsequent transports (to a total of eight) cost $12,800 each.

Our Observations

It is in this area of secondary storage that the large number of possible configurations of a computer system become apparent. With these possibilities come also cost versus capability tradeoffs. After examining the possibilities, one choice we might make is to double the disk capacity (from two 5.2 MB drives to two 10.4 MB drives) for an increased cost of approximately $3,000. This cost could possibly be balanced by decreasing the amount of central memory purchased if 256K bytes are not needed.

Other choices, as indicated by the users we contacted, which further enlarge the number of possibilities include the use of non-DEC devices. Most users reported having DEC's RL01 disks, but many were using other manufacturer's hard disk systems. Though the users we surveyed reported few hardware problems, the problems they did experience were most often disk related. Users were generally satisfied with DEC's response time and their ability to repair the problem immediately. One user did have continued problems and finally received a new disk drive since, after repeated attempts, DEC could not repair the old drive.

User Comments

- *Had some initial problems with the disks, but they're working fine now.*

- *Have not had any significant problems at all, just the usual little hardware problems that everyone has.*

INPUT/OUTPUT DEVICES

Summary of Equipment and Features

- DEC offers a full line of input/output devices including printers, hard copy terminals, video display terminals, and a card reader. The printers cover a wide range of speeds (180 characters per second to 300 lines per minute) and are available with 64 or 96 character sets. The prices of these printers run from about $4,000 on up, depending on capabilities ($12,600 will buy a 64 character set, 300 lpm, 132 column printer).

- The DEC terminals include the 30 cps LA38 hard copy terminal ($1,700) and the 180 cps LA120 hard copy terminal. The VT100 video display terminal costs $2,050.

- DEC also supplies communications interfaces including an eight-line multiplexer for $2,450 (expandable to 16 for another $1,950) and a 16-line multiplexer for $4,100.

Our Observations

We've always enjoyed DEC terminals and printers, and the ones we used in our benchmarks were no exception. We've found DEC printers to be fast, clean-printing, and quiet. We also enjoyed the VT100 terminal with its detachable keyboard and separate numeric pad. The VT100 also features two screen widths (132 columns by 14 lines and 80 by 24), split-screen capability, and a variety of advanced video options including bold, blink, underline and reverse video.

As with the storage devices, many of the users had attached non-DEC peripherals. Nearly half the users we contacted were using printers not made by DEC, while several were using non-DEC terminals. In fact, several users commented that one of the chief advantages of DEC equipment is that there are many non-DEC peripherals available for the 11/34, and this can present a significant cost savings over purchasing a non-DEC processor and then being restricted to a limited choice of peripherals.

User Comments

- *There's lots of peripherals available to hang onto DEC equipment.*
- *The VT100 terminal is really great! The function keys are good, it's reliable and operator oriented.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- The Datasystem 355 comes with the CTS300 operating system, but can be upgraded to the more powerful CTS500 operating system. CTS300 supports DEC's DIBOL-11 programming language and provides multi-user, multi-terminal capabilities (up to eight terminals).

- CTS300 includes a variety of utilities for file manipulation, data communication, and data management. It also includes the DECFORM Data Entry 300 utility which is used for designing data entry functions.

Our Observations

We found CTS300 to be a well thought out but "standard approach" operating system (i.e., line-oriented, not menu-driven). The operating system is designed for interactive use, but provides indirect command files, which allow users to invoke a whole set of system commands by issuing a single, one-word command.

CTS300 provides multi-terminal capability through the use of dynamic partitioning. This method lets each terminal's program use its own "chunk" of memory which can change as needed (if there is memory available). In addition, to conserve memory, executing programs may call subroutine overlays. This procedure reduces the amount of memory to run a program by allowing program segments to be brought in only as needed and "overlayed" in the same spot as previous segments.

CTS300 allows the user to set program execution priorities. That is, the system can allocate the central processor's time among all the programs running. This allocation can be on an equal basis, or more (or less) time can be allocated to certain programs.

CTS300 includes a full selection of utilities including:

- Text Editor - used to create and modify ASCII files such as data files or DIBOL source programs.
- Sort/Merge - permits the user to define the parameters for sorting and merging data files. It actually generates a DIBOL program which does the required sort or merge.
- Linker - converts DIBOL compiler output into a run-time format.
- Device Utility Program - general disk support utilities.

- Librarian - creates and maintains libraries of commonly used programs.

- FILEX - a file exchange program which creates copies on floppy disks that are compatible between Datasystem 300s and 500s, and creates IMB-compatible diskettes in 3741 format.

CTS300 also offers DECFORM, a form compiler that processes screen format directives and generates a DIBOL source program, which when compiled and executed performs the specified data entry functions. DECFORM gives the user a tool to facilitate "form-fill-out" data-entry program development.

It is possible for a Datasystem 355 user to upgrade the operating system to CTS500 (at a cost of $13,800). CTS500 is a much more powerful operating system whose added features include:

- COBOL, FORTRAN and BASIC languages in addition to DIBOL.
- More advanced timesharing capability including a 16 terminal capacity.
- More file management utilities.
- More expansion capability, including the use of larger disk storage devices (up to eight 176 megabyte drives).

Most of the negative comments we received in our user survey were in the area of operating systems. Those who had owned their system for over two years had used version 4 of CTS300, a system notorious for its innumerable "bugs." Its successor, version 5, however, has been well received. Version 6 of CTS300, as yet unreleased, has undergone rather extensive field testing as DEC is apparently trying to avoid their earlier problems. A more complex operating system, RSX11M, is available, as well as a third-party system called TSX. A typical complaint about CTS300 is that you cannot do program development, editing, and compiling, while you are simultaneously executing an application program. However, this limitation has been removed in the new version 6.

User Comments

. *The error messages are lousy, they seem to be oriented towards system types. You have to have a DP person to run it.*

. *Version 5 is very good . . . and I like the indirect files.*

. *As a first-time user I'm quite satisfied.*

. *DEC operating systems are hard to get up and running. The system procedure is long and error prone.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- The Datasystem 355 comes with the CTS-300 operating system which includes only the DIBOL-11 programming language. COBOL, FORTRAN and BASIC are available under the CTS-500 operating system.
- DEC has announced that it will be offering a general business package (receivables, payables, general ledger, payroll and inventory) to its OEMs and end users of the Datasystem 300s by the end of 1980. Up to this point, DEC had only been offering application packages to DECstation computer system users.

Our Observations

DIBOL is Digital's own high-level business-oriented language. Combining the data definition features similar to COBOL with more concise procedural statements like FORTRAN, DIBOL provides these kinds of capabilities:

- Data manipulation and arithmetic expression evaluation.
- External calls to other programs.
- Sequential, random and indexed access to files.

In addition, DIBOL offers an on-line (dynamic) debugging utility that facilitates isolating and correcting program errors.

Nearly all of the users we surveyed were using DIBOL for at least some of their programming. In general, they were very happy with DIBOL, citing its efficiency and easily learned statements. Many were happy with DIBOL's upward compatability within the DEC PDP-11 line and indicated this was a big factor in any decision to upgrade their system. The only negative comments given regarded the fact that DIBOL is not portable (not generally available on non-DEC equipment).

User Comments

. *I'm really very happy with DIBOL . . . I'd never consider using COBOL.*

. *The only problem with DIBOL is it's not transportable.*

SUPPORT SERVICES

Summary of Features

- DEC supports contract maintenance and T&M (time and material) maintenance on its equipment.

- System software maintenance depends upon who installs and who supports the system. Either DEC or the customer may install the system, and either may provide support. For DEC supported system software, the support originates at the local DEC office with personnel on call. If the user supports their own system, then a 'hot-line' is available for a fee. There is a warranty period during which DEC provides free support. The 'hot-line' support includes a monthly publication, automatic updating of software, and other items.

- DEC is a strong supporter of DECUS, the DEC users group. Annual meetings are held which provide product information, updating, seminars, etc. DEC is just beginning its direct support of local chapters of the user group.

Our Observations

DEC seems particularly interested in continued support of the DECUS system. They are becoming more user oriented, and are developing applications packages which can be personalized by OEM's or used directly by final users. Many users felt that the support and information available through the DEC users group was a definite plus in choosing DEC equipment.

In addition to DEC's direct support, the user should investigate the support reliability of the OEM supplying the equipment. In purchasing a system in this price range, the user is often assumed to be more 'computer-wise' or is capable of becoming so. Therefore, satisfaction with the equipment seems to be less a function of satisfaction with the OEM than it is on the lower priced machines evaluated in our Series 1 and Series 2 reports.

Users were generally happy with the hardware support provided by DEC, and indicated that response time was generally within a few hours, and repairs were effected immediately. Recent software support has been good, and systems have been reliable.

User Comments

. *DEC's hardware service is really quite good. I'd rate them a 10 out of 10.*

. *Training from DEC was very good . . . haven't used up all my training credits yet.*

SUMMARY OF USER COMMENTS

Using names supplied by the Association of Computer Users, we contacted 13 users of DEC's 11/34 based systems. This system is being used in a wide variety of applications from standard business systems to engineering design and graphics by sophisticated system analysts to first time users.

The DEC 11/34 based systems were being used in retailing, manufacturing, and consulting types of businesses, as well as one college. While the average system was being used by four people, eight hours a day, five days per week, several systems had ten or more terminals connected and/or were being used up to sixteen hours a day, seven days a week.

While the typical system had been used for two years, experience ranged from three months to three years. Most users had some DEC peripherals attached to the system, particularly the RL01 disk packs and DEC CRT terminals, many were using hard disk storage and terminals made by other manufacturers.

Approximately half of the systems were being used for accounting applications such as accounts receivable, payables, payroll, etc. Additional uses included order entry, purchasing, data management systems, word processing, graphics, tax return preparation, job costing, and marketing information. Several users had developed applications for their own businesses and were planning to market those as packages to others.

While we conducted our benchmarks using the CTS300 operating system, 5 of the 13 users we contacted were using the CTS500 operating system which includes FORTRAN, COBOL, and BASIC, as well as DIBOL. It was in this area of operating systems that we received the most negative comments about DEC. Those who had owned their 11/34 for over two years had passed through version 4 of the CTS300 system, one which was notorious for having many 'bugs' in it. However, version 5 of CTS300 was well received. The more recent purchasers of 11/34 based systems have nothing but good comments about the DEC operating systems.

The majority, by far, of the users were using DIBOL for at least some programming. The other common languages were FORTRAN and BASIC. Also, two users were using the <u>C</u> language developed at Bell Laboratories, and two other users were

considering its use. The users we talked to were very happy with DIBOL. They indicated that it was an efficient language, and very easy to learn. The only negative point is that it is not a portable language since it is generally not available on non-DEC equipment. However, it is upward compatible within the DEC line.

Hardware maintenance was generally performed by DEC, and users were happy with the service. There were a couple of negative comments about T&M (time and materials) service from DEC, in that they were not as responsive as they could be. Hardware problems were disk related, and users were generally satisfied with DEC's response time and ability to repair the problem immediately.

Software maintenance was generally not a problem except for those involved in version 4 of CTS300. One user did comment about the cost of implementing 'fixes' in the operating system.

Of the nine people considering hardware upgrades, eight would stay with DEC equipment. Five of these individuals were considering the purchase of the 11/44 based equipment because of the larger memory capacity. Four users were going to add memory and/or disk capacity to their 11/34 system.

The most frequently mentioned alternatives to DEC equipment were Data General and IBM. Additionally, users had considered Wang, NCR, and HP as well as Prime, Univac, Microdata, Singer, Sperry, Honeywell, and Burroughs. The overwhelming reason mentioned for choosing DEC was hardware reliability.

When asked to indicate the most important criteria in choosing their computing systems, users responded, in order of frequency: software availability, reliability of hardware, manufacturer's reputation, hardware service, third party peripherals, speed, and cost.

Overall, users are very satisfied with their DEC 11/34 based system. They felt they received good support from DEC, and several indicated that DECUS, the DEC users group, was a decided plus in choosing DEC equipment. The fact that most would upgrade within the DEC line is an indication of their satisfaction.

CONCLUSIONS

The DEC Datasystem 355 reviewed in this report is based on the widely used PDP 11/34 central processor. DEC produces very reliable computing hardware which is the principal reason the users we surveyed chose the DEC system over other manufacturers.

The benchmark times for the single-user component of testing indicated that this system performs significantly better than those single-user systems costing under $25,000. Times on the Datasystem 355 were better than half the average times recorded on those less expensive systems. For the multi-user benchmark program there was a degradation in response time as additional user terminals were added to the system. Moving from two to eight terminals increased response time by a factor of three (from 5 to nearly 17 seconds). Adding a ninth terminal running the CPU-intensive program further increased response time. Additionally, execution of the CPU-intensive program slowed considerably as terminals were added to the system.

Users were very satisfied with the hardware maintenance support provided by DEC. While early versions of the CTS300 operating system were notoriously full of "bugs," the more recent versions are very reliable and user satisfaction is high.

Many users were programming in the DIBOL language. They were very satisfied with the ease of learning this language, and its efficiency in terms of programming speed and accuracy. The only problem with the language is its transportability to other systems. However, since most users intended to stay within the DEC line of equipment, this was not perceived as a major problem.

Uses of the 11/34 based system ranged from accounting applications to technical engineering design problems. Many users had developed extensive applications for their own business, and were in the process of selling the package to other users.

Overall, the Datasystem 355 is a reliable piece of equipment, with many software packages available, and many third-party peripherals which could be attached. The proof of satisfaction is the large number of users who intend to upgrade within the DEC line.

NEXT ISSUE: WANG 2200MVP

BENCHMARK REPORT

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The Association of Computer Users is a world-wide professional organization devoted to providing an unbiased source of user oriented information on computers for business and scientific applications. It is organized as a nonprofit association to represent and serve computer users, and to provide a forum for the exchange of information about the many systems in use today.

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BENCHMARK REPORT

ASSOCIATION OF COMPUTER USERS

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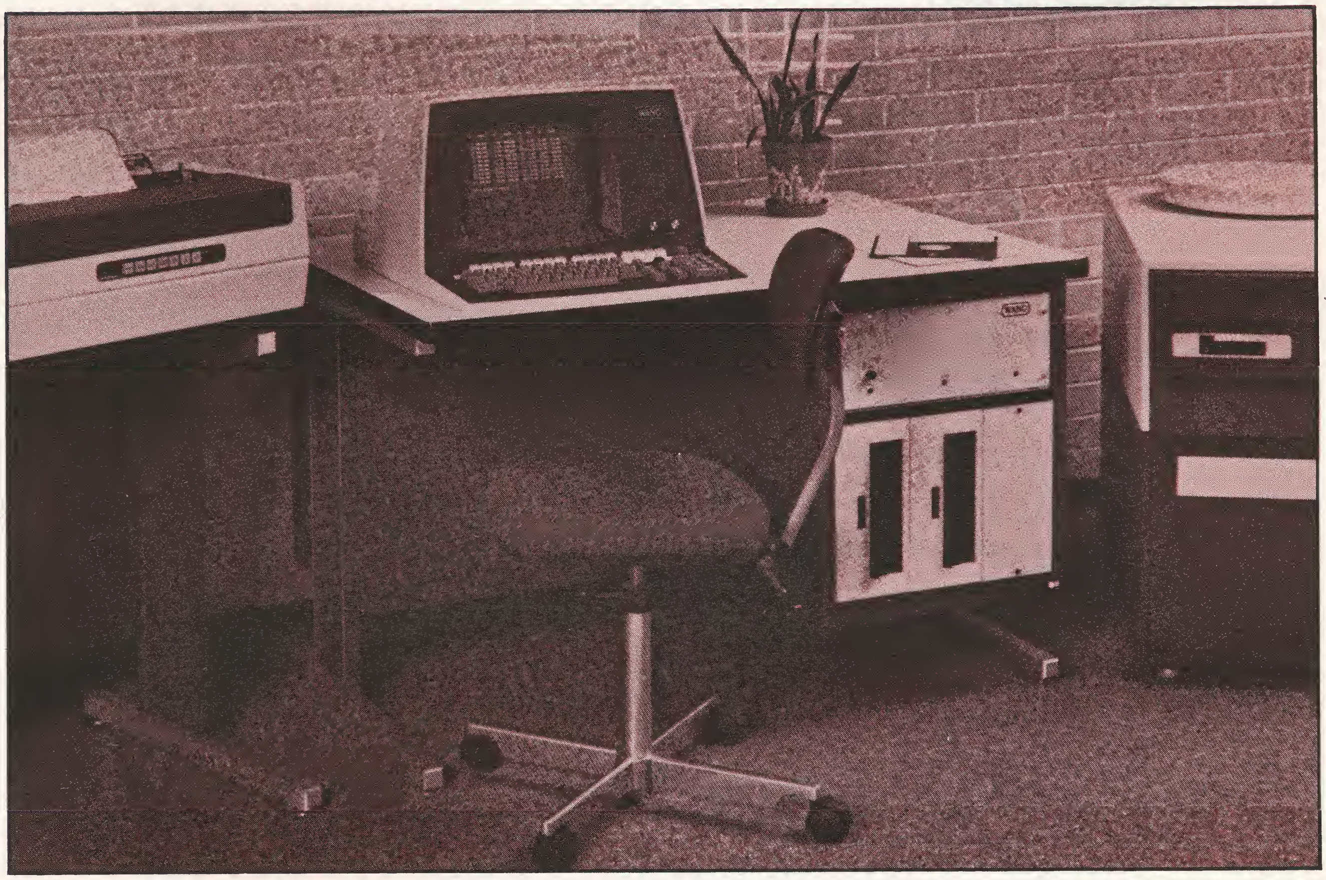

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WANG 2200MVP: BENCHMARK REPORT

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PREFACE

The Wang 2200MVP is the second computer to be evaluated in this series of reports covering multi-user computing systems in the $25,000 to $50,000 price range. The goal of this series is to provide users with comparative information on a number of systems for use in selecting from among the many alternatives available--information which is simply unavailable from any other independent source.

In evaluating computing systems, the technical specifications supplied by manufacturers are often difficult to interpret and are seldom comparable across different computers. The potential buyer needs to know how well the equipment performs in specific applications, and how that performance compares with other computing systems. Additionally, subjective factors such as ease of use, versatility, and support services must be considered as a part of the choice process.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order-entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

Wang Labs 2200 Series MVP computer used in our benchmark tests was configured with the 2200MVP central processor, 128K bytes of central memory, 5.0 megabytes of hard disk storage, two 4-port terminal controllers, a 200 character per second matrix printer, and a Wang Interactive Terminal. The price of this system is $34,500 (5 additional terminals would bring the price up to $48,000).

- The 2200MVP is fast. The timing on the CPU Intensive test for the 2200MVP is only one second slower than that of Wang's single user 2200VP tested in our Series 2 reports (15.2 versus 14.2 seconds), and the 2200VP was the fastest machine tested in that series!

- The Series 2200MVP does not have what most users would consider an operating system. That is, there is no "job control language," no operating system mode versus program development mode, and none of the other operating system/program mode dichotomies many of us are used to. All commands, utilities, etc. are part of Wang's BASIC-2 language.

- Wang's BASIC-2 programming language is a highly enhanced version of BASIC. Designed with the business environment in mind, BASIC-2 users feel the interpretive language/interactive environment facilitates program development. As one user put it, "There's no better way."

- Between third-party software houses and Wang itself, there is a staggering array of software available for the 2200MVP. Wang maintains an extensive network of "Wang-approved vendors" (software firms, approved by Wang, who sell packages for Wang hardware), offering numerous business and engineering packages for a variety of businesses and industries.

- The only negative comments about Wang were in the user/company interface, where several thought that information from the company was weak or non-existent, particularly in the early stages of trying to get the machine running and understanding its operation.

Overall, we were very impressed with the operation of the Wang 2200MVP, and would feel very comfortable programming in its environment. We particularly like the memory partitioning on the 2200MVP, and the global data areas which can be used for inter-program communication. It is easy to see why program development time could be significantly reduced in the 2200MVP interpretive BASIC system.

BENCHMARK REPORT

SYSTEM: Wang 2200MVP

PRICE AS TESTED: $34,500

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-4	N = 3000	15.2 seconds
	I/O INTENSIVE	
B-4	N = 3000	11.2 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	2.8 seconds
D-2	4 terminals	3.0 seconds
D-3	6 terminals	3.3 seconds
D-4	8 terminals	3.5 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	2 terminals . .	15.5 seconds	3.5 seconds
E-2	4 terminals . .	15.8 seconds	3.8 seconds
E-3	6 terminals . .	16.0 seconds	4.1 seconds
E-4	8 terminals . .	16.4 seconds	4.6 seconds

Note: Order Entry Program times represent average processing time per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Wang Laboratories, Inc. and requested their assistance in benchmarking the Series 2200MVP computer system. We requested that the total system be priced in the $25,000-$50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 limit (as it would in this case), we advised Wang that we would report the cost over-run, but would continue to benchmark the computer using up to eight terminals.

Wang provided us with a Series 2200MVP at their office in Denver, Colorado. The system consisted of a 2200MVP processor with 128 Kilobytes of central memory, a 5.0 megabyte hard disk storage device, two 4-port terminal controllers, a Wang Interactive Terminal, and a 200 cps matrix printer, at a price of $34,500. Five additional Wang Interactive Terminals (at a cost of $13,500) could be purchased for a total cost under $50,000. Wang also supplied us with programming and other on-site technical support for our benchmark.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, the North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the 2200MVP) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of one computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

Benchmarking the 2200MVP

One visit was all that was required to benchmark the MVP. Upon arrival, our

equipment was set up and communications between our Remote Terminal Emulator system and the 2200MVP were quickly established. After working out a couple of minor program "bugs" with the help of Wang personnel, the benchmarks were then easily performed with no further problems.

Our Observations

Perhaps one of the more noticeable features when you examine the 2200MVP is its small size, particularly the processor. Unlike many manufacturers who find it necessary to package their processor in mostly "air-filled" cabinets, the 2200MVP processor and I/O slots come in a metal case no larger than a standard-sized suitcase. In fact, the processor we used was brought to Denver by Wang personnel on a plane, as carry-on luggage. This processor case sits in the back of a desk provided by Wang (see cover photo). The desk, in addition to holding the processor, provides a recess for a terminal and space for the optional diskette drives.

The next thing you might notice is that (to paraphrase), "fast things come in small packages." This Wang machine is fast. Though Wang discloses little technical information concerning the architecture of their processor, our discussions with Wang personnel regarding the technical aspects of the machine revealed, in our opinion, a well thought-out approach to hardware design.

From a programmer's point of view, Wang again takes a unique approach. In most minicomputer systems we've come in contact with, there is a distinction between the operating system and the programming environment. The operating system has its own "job-control language" (JCL) which allows the user to perform various utilities, compile and execute programs, and so on; there is usually an editor or program development mode which is distinct from the operating system, though some JCL may be allowed in this mode. This typical arrangement is not the case on the MVP. Instead, there is no clear difference between operating system and program development modes. The operating system, without what you could call a JCL, is basically transparent to the user.

Once the system is up and running (essentially after a system generation), the user is free to write a program, execute a program, use utilities, or edit corrections, all without changing "modes." All commands on the MVP are either BASIC-2 functions, BASIC-2 system commands (LIST, REMEMBER, SAVE), or RUN commands to execute user-written (or Wang-written) programs or utilities.

Configuring the system on the MVP consists essentially of dividing the system resources (memory, printers, and so on) among the users. This is accomplished using a utility program supplied by Wang (@GENPART) which allows the user to create, save, and execute system configurations. When the system is turned on, @GENPART is automatically run. The user then may interactively create a system configuration. Alternatively, @GENPART can automatically execute a previously created system configuration and/or allow other user programs to be loaded and executed, with no further operator intervention. During our benchmark testing, we found this system configuration procedure to be easy and fast. At one point, it became necessary to "re-allocate" central memory. This was accomplished in less than a minute, with little difficulty.

The multi-terminal order-entry system which we used in our benchmark test was programmed in BASIC-2 by Wang personnel. To run eight terminals, 14 partitions were created, one of which could be considered the console or "control" terminal (terminal #1). Of the 13 remaining, 8 partitions (analogous to 8 terminals) contained "calling" programs that used common routines contained in the remaining 5 partitions. This ability for two or more partitions to simultaneously execute the same statement(s) in shared subroutines helps to conserve and efficiently use the central memory available for a multi-user task.

Because it is necessary to allocate all of the central memory among the partitions, any "left-over" or unused memory is not immediately obvious. Our order-entry system did fit "comfortably" in the 128K of user memory available, with some unused memory available for re-allocation if necessary.

Printed output from the order-entry program was all generated after the terminals had stopped their entries.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that use repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	15.2 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,275 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time

on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	11.2 seconds

Comment: *In Wang's version of BASIC, output to the disk is always in blocks of 256 bytes, regardless of the number of bytes contained in the data list of the output statement, and the I/O program would have used 3000 sectors of disk space. Wang personnel re-wrote this job using program data blocks of 28 numbers. Thus, the job actually performed only 108 write accesses and 74 read accesses to the disk. Results of this program are not directly comparable with other I/O times reported in this series. (See Series 2 report on the Wang 2200VP)*

"Real Life" Problems

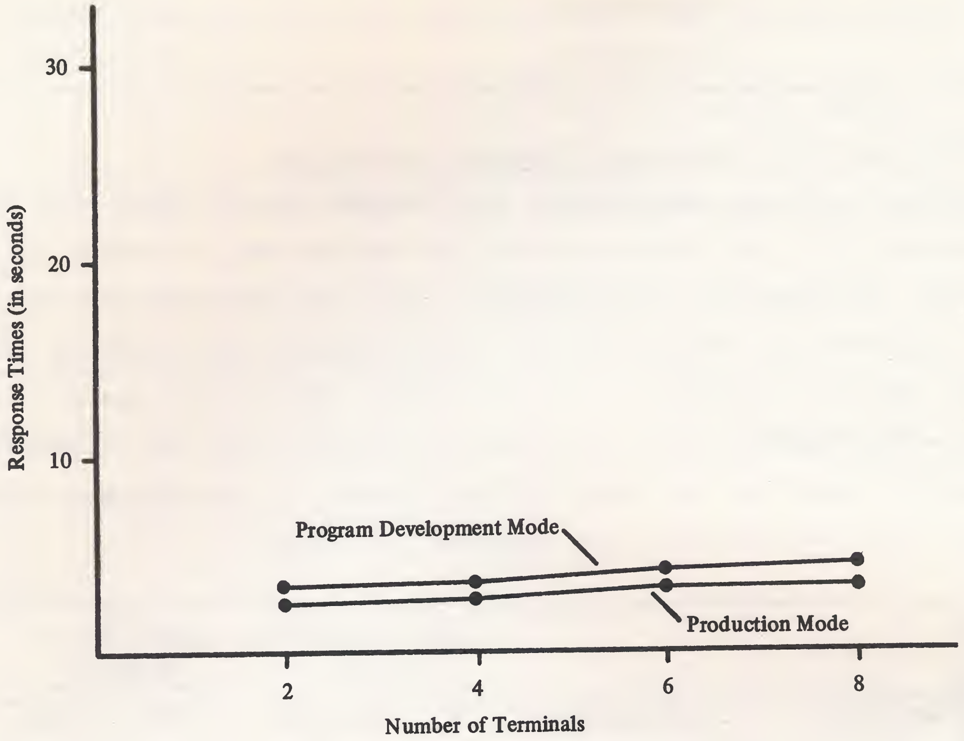
This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

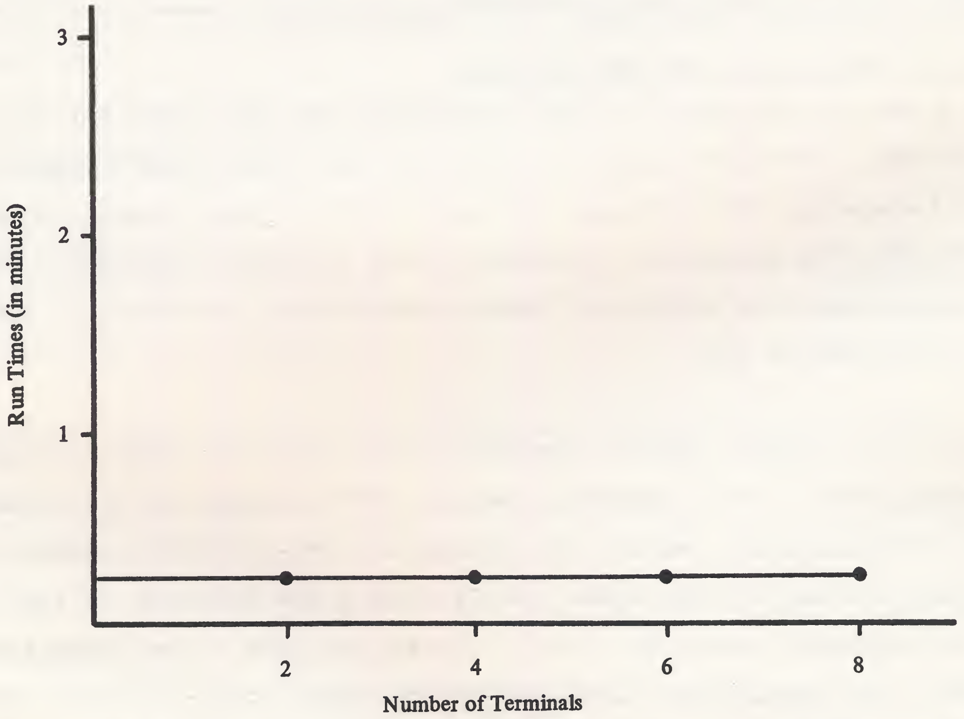
Order Entry Run in Production Mode

The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



D-1	Results:	2 terminals	2.8 seconds
D-2		4 terminals	3.0 seconds
D-3		6 terminals	3.3 seconds
D-4		8 terminals	3.5 seconds

Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, while the order-entry program with multiple terminals (2, 4, 6, and 8) is running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	15.5 seconds	3.5 seconds
E-2		4 terminals	15.8 seconds	3.8 seconds
E-3		6 terminals	16.0 seconds	4.1 seconds
E-4		8 terminals	16.4 seconds	4.6 seconds

Analysis of "Real Life" Problem Results

The two graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for 2, 4 6, and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-intensive job.

Note that in all cases, adding terminals slows response times. In production mode, moving from 2 to 8 terminals causes a 20% increase in the processing time for a transaction. Adding the background CPU-intensive program increases the average processing time about 20-30% with a 30% increase in time as the number of terminals goes from 2 to 8. In an absolute rather than a relative comparison, the degradation displayed by the order-entry is quite small.

SYSTEM AS TESTED: WANG 2200MVP

Costs

The configuration of the Wang Series 2200MVP used in this report is:

• 2200MVP-32 central processing unit, 9 I/O slots, with extended configuration chassis, 128Kb of central memory	$15,000
• 2260C-1/2 5.0 megabyte hard disk drive (2.5 fixed/2.5 removable) with 22C12 disk controller and 2297 stand)	9,200
• (2) 2236MXD 4-port terminal multiplexer ($1,200 each)	2,400
• 2236DE Interactive Terminal	2,700
• 2221W Matrix Printer (132 column, 200 characters/second)	5,000
• 22C02 printer/drum plotter controller	200
Total System	$34,500

Our Observations

Additional 2236DE Interactive Terminals are priced at $2,700 each. Keeping total cost under $50,000, five additional terminals could be purchased.

Configuration	Total Price
System with one terminal	$34,500
System with two terminals	$37,200
System with four terminals	$42,600
System with six terminals	$48,000
System with eight terminals	$53,400

Included in these prices is the operating system and Wang's BASIC-2 language.

Summary of Equipment and Features

- The Wang Series 2200MVP uses the 2200MVP central processor. This processor comes with from 32K to 256K bytes of central memory and contains nine I/O slots used to mount I/O controller boards. Because some I/O controller boards control multiple devices (such as the 4-port terminal controller), the system is not actually limited to just nine peripheral devices. The processor with 32K memory costs $9,000, processor with 64K memory costs $12,000, with 128K costs $15,000, with 192K costs $18,000 and with 256K costs $21,000.

- Central memory can be upgraded, with the cost determined by the amount of memory to be added and the amount originally installed. For example, to upgrade from 32K to 128K costs $8,000 while upgrading from 64K to 256K costs $13,000.

Our Observations

The 2200 MVP utilizes a fixed-partition memory scheme. In a fixed partition system, user memory is divided into a number of sections or "partitions," each of which can contain a separate program. Up to 16 partitions can be assigned on the MVP.

The CPU services partitions in a "round-robin" fashion, allowing each program to execute for a brief period before moving on to the next partition. If a program is performing an I/O operation, it will be "ignored" by the CPU until the I/O is completed, allowing more CPU time for the other partitions. This overlap method helps to keep the CPU constantly active (i.e. it is not waiting for the much slower I/O operations to be completed) and helps provide fast multi-user response times.

Unlike many multi-user systems, the 2200MVP does not store its system programs (operating system and languages) in user memory. A separate "control memory" of approximately 60K bytes is used to store the system. This control memory is a separate, protected memory area which cannot be accessed by the user or the user's programs. This helps to protect the system from accidental interference or destruction by a user program.

User Comments

- *The package is very good . . . a black box with handles, cables, and everything you need.*

- *With Wang you get more CPU for the money, though peripherals cost you more.*

STORAGE DEVICES

Summary of Equipment and Features

- Wang offers a good assortment of hard disk devices for the MVP. The 2260C series offers 2.5 megabytes (1.25 Fixed/1.25 Removable) for $7,200, 5.0 megabytes (2.5 F/2.5 R) for $9,200, 10.0 megabytes (5.0 F/5.0 R) for $11,200, and 20.0 megabytes (10 F/10 R) for $18,400. For an additional $800 on the cost of the drive, the 2260BC series offers the same capacities as well as multiplexing capabilities. The 2280 Series offers 26.8 megabytes (13.4 F/13.4 R) for $19,000, 53.6 megabytes (40.2 F/13.4 R) for $20,000, and 80.8 megabytes (673 F/13.4 R) for $21,000. All prices given include the disk controller and the disk processing unit in the case of the 2280 series.

- 8-inch diskette drives are available as well. Costs run $3,800 for 250K bytes of storage, $5,300 for 500K, and $6,800 for 750K.

- The total amount of disk storage available is very large. The numbers of 2260 series 20 megabyte drives that can be attached is limited only by the number of I/O slots (of the 9 total) the user has available. In the case of the 2280 series, up to 6 drives could be attached for total on-line storage of 484 megabytes.

- Wang also offers a 1600 bpi, 9-track tape drive with controller for $15,000.

Our Observations

The multiplexing capability available on the 2260BC series allows several independent systems (i.e. different processors) to share a single disk unit. The participating systems may have a specified portion of the disk for dedicated use or may share a common data base.

Most users were using the 5 or 10 megabyte disk units, and were happy with the storage capabilities. Two users also had floppy disk storage available on their systems.

User Comments

- *Wang's electronics is very good, but I've had a lot of mechanical problems with the 10 megabyte drive.*

- *Quite a few problems with the 10 megabyte disks, but the 80 megabyte drives are very good.*

- *Wang is very good. I've just had a couple of minor mechanical problems.*

Summary of Equipment and Features

- The Wang printers available include a matrix printer (132 columns, 120 character per second) for $3,400, a line printer (600 lines per minute, 64 character set) for $16,200, and a band printer (600 lpm) for $12,200. In addition, a flatbed plotter (31" by 48") is available for $8,000.
- Wang terminals include their Interactive Terminal ($2,700) and a graphic CRT ($3,600).
- A punched card reader is available for $6,500.
- Wang offers a buffered asynchronous telecommunications controller ($750), a bisynchronous controller ($1,500) and a bisynchronous controller for IBM 3275 emulation ($1,700).

Our Observations

The Wang Interactive Terminal consists of an 80 column by 24 line CRT and attached keyboard. The CRT can display up to 1920 upper/lower case characters. Some CRT features are programmable underscore, cursor positioning, character attributes and box graphics. The keyboard is the standard typewriter layout with a 10-key numeric pad and 32 user-definable function keys.

User Comments

- *The function keys are very useful.*
- *The keyboard is very good and the users like it. Viewing is excellent and you don't get tired, even after using it all day.*
- *The touch on the Wang is much better than the IBM.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- The 2200MVP comes with an operating system, Wang's BASIC-2 language, and system diagnostics. Unlike many multi-user systems, there is no distinction (to the user) between the operating system and program development/execution mode. They essentially appear as one and the same. There is no job control language per se. All commands are either executable BASIC-2 functions or commands to execute a BASIC-2 program that will accomplish the necessary task or utility.

- Wang provides a utility (which is a BASIC-2 program) called @GENPART, a system generation (or configuration) routine. In addition, Wang sells ISS (Integrated Support System), which contains a full line of utilities used for programming support and disk related activities.

Our Observations

As mentioned on the Central Unit detail page, the 2200MVP operating system supports multi-user operations by using a fixed-partition memory approach. User memory consists of from one to four "banks," each of which may contain up to 64K bytes. Each bank may be divided up into partitions (minimum size of 1.25K bytes), with each partition capable of running a separate program. A total of 16 partitions are allowed, supporting up to 12 terminals (thus, any given terminal may control more than one partition).

Within each bank, some memory is required for operating system overhead (3K bytes the first bank, 8K bytes in each subsequent bank). In addition, each partition within a bank requires about 1K bytes of overhead for program control and buffering.

The number of partitions in a system and the size and characteristics of each are established in a process called "partition generation." Wang provides a utility program called @GENPART which accomplishes this. The user can create a number of system configurations, save them on disk, and access them whenever needed. Optionally, the user can designate a particular "default" configuration which will be automatically loaded and executed whenever the system is powered up.

We found the 2200MVP to offer some interesting features that were designed to ease the task of programming for a multi-user environment. These features include:

- Global Partition -- Any partition may dynamically declare itself "global," thus making its subroutines and any specially labeled global variables accessible to other partitions in its bank of memory. The BASIC-2 program text in a global partition is "re-entrant," that is, two or more partitions may simultaneously execute the same statement in a shared subroutine. Global variables can be interrogated and modified by several users, providing a mechanism

for interpartition communication. In addition, there is a 5K byte area in the first bank of memory that can be divided into "universal global partitions." These universal partitions can be accessed by all other partitions on the system (in any bank).

- Seize/Release -- This capability allows any given program running on the system to temporarily "seize" a peripheral device such as a disk or printer. This allows a program to use a shared device, and while in use, prevent other programs from interfering (especially useful for printers).

- Inter-terminal Messages -- This facility allows the operator at terminal #1 to define a message which will be displayed at all other terminals whenever the READY system message is displayed.

- Disabled Programming Mode -- This option allows the user to define given partitions (terminals) as "disabled". That is, the partition is totally under program control. The operator cannot enter or modify program text from that terminal, nor directly access any disk files.

ISS, Wang's Integrated Support System, offers support software for the 2200MVP. The major components of the package are:

ISS Utilities -- a variety of operator controlled utilities including copy/verify, list/cross reference, file status, and so on.

Screen/Disk Subroutines -- a set of subroutines that perform potentially complicated functions which the user may include in application programs.

SORT-4 Subsystem -- a sort subsystem that may be incorporated by the user into an application program.

Key File Access Method (KFAM) -- an indexed, disk file access method that includes utilities, subroutines, and a subsystem.

User Comments

- *The operating system is a relief . . . it is very nice to operate within.*

- *The interactive usage is great. You just stop the program, make corrections, and re-start. Its very nice to use.*

- *Software development is very nice, particularly the ease of editing and the use of 'breakpoints' in debugging programs.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- The only language available on the 2200MVP is Wang's own BASIC-2.

- Wang offers a powerful program development tool called IDEAS (Inquiry Data Entry Access System). IDEAS can be used to create and maintain data files, generate screen formats and menus, solicit and validate operator-entered data, and produce reports. IDEAS creates the BASIC-2 code which accomplishes these tasks. The code can be used as is, or can be modified or further customized by the user.

- An enormous amount of application software is available for the MVP. Wang offers a number of packages, the most significant of which is GBS (General Business System). GBS is a general package that includes invoicing, accounts receivable, sales analysis, order entry, inventory, general ledger, accounts payable and payroll. Though available from Wang, GBS is typically installed by software vendors. Wang "approved vendors" install Wang software and offer a large assortment of their own business and engineering packages.

Our Observations

Wang's BASIC-2 is a highly enhanced version of BASIC. A very powerful language, it provides the programmer with a variety of features including:

- Logical operations and data manipulation at the bit and byte level.

- 13 Digit accuracy from a full array of math and trig functions.

- Groups of special-purpose statements to perform operations such as code conversion, sorting, and matrix arithmetic.

We found that BASIC-2, like any powerful higher-level language, can be complex, with a multiplicity of statements and procedures. But being an enhanced BASIC, it was a relatively familiar language which we felt we could "ease into" comfortably.

User Comments

. *It's a very good version of BASIC . . . better than most.*

. *It's very easy to write friendly programs for the user but, because of the short variable names, it is more difficult to document and maintain the programs.*

. *The 'global' facility makes it very easy to pass information among programs. However, it's a bit complicated so you have to be careful.*

. *Wang has a very nice implementation of BASIC.*

Summary of Features

- Wang provides contract maintenance on the hardware it sells.

- System software support (BASIC-2 and the operating system) is provided by Wang. All modifications and updates to the system are provided free of charge. In addition, there is a toll-free line to Wang technical reps when the user has questions.

- Application software is almost exclusively installed and maintained by Wang approved vendors.

Our Observations

Though Wang has developed their own application software (like GBS), their approach is to sell the hardware and leave the software to their approved vendors. Wang's approach is not like some other manufacturers, though, who sell the hardware and leave the user to solve his own software problems. Typically, when a user purchases Wang equipment, the Wang salesman (and a Wang technical analyst, if needed) will help the user determine their software needs. The salesman, who has at his disposal a lengthy list of the packages offered by Wang approved vendors, will then help the user find a vendor (or vendors) who offers the package which suits the user's needs. Unfortunately, users seemed less than satisfied with the service they received.

User Comments

- *Wang's technical service is great, but the sales-service and follow-up is very poor. There was no information available on software.*

- *Wang is lax on training. It's up to the programmers to learn the system.*

- *I went to Wang's four-day programming school and was very impressed.*

- *Wang gave us no training . . . we just had to look it all up. The technical representative never even showed up when the equipment was installed.*

- *Hardware documentation is very good. However, the software documentation is incomplete and not too good. It may be six months to a year behind the actual version of the system which is up and running.*

- *Wang's documentation is clear and complete. It's good for learning and as a reference. Very well documented.*

SUMMARY OF USER COMMENTS

Using names supplied by the Association of Computer Users, we interviewed ten users of the Wang 2200MVP system. The majority of these users had systems configured with 64 kilobytes of user memory, but one had 128K and one had 256K of memory. Five users owned the 10 megabyte disk storage unit, two had 5 megabyte units, and three had 80 megabyte drives. A variety of printers were being used, although four users had but a single printer in the 180 character per second (cps) range, and the remaining users had two printers, generally a low speed unit at 120 cps, and a high speed unit at 200 lines per minute (lpm). All were using a version of the 2236 CRT terminal, with anywhere from two to seven terminals on the system. Three of the users had dial-up capability and were using this facility for some applications. One user had graphics capability.

The systems in the survey were being used by three to six people, although two users had up to twenty people accessing the system. The systems were typically being used 6 to 8 hours per day, but one firm was on a 24-hour shift 5 days per week with dial-up access.

The majority of applications were in the business management area. Only one user was involved with engineering modeling and computations. Five users had accounting applications and three had order entry. The 2200MVP is apparently being used extensively in the insurance industry with applications such as pension plan administration, actuarial computations, insurance plan costing, etc. Additional uses included job costing in a manufacturing environment, financial modeling, salesman and phone call logging, and time and billing for a personal service firm.

Users were generally very happy with the 2200MVP BASIC language imbedded within the operating system. Some particular features mentioned were matrix operations, formatting of output, and global memory areas for passing information among programs. From a programmer's standpoint, it was perceived as a very friendly system to program, and very efficient in its use of a programmer's time. If you are running a program and there is an error, all you do is simply correct the error and re-run the program. This interactive approach is in sharp contrast to the standard operating system where you must go through the time consuming process of editing, compiling, linking,

loading, and executing. Several users commented about this feature, and one even suggested a ten-fold reduction in program development time over standard operating system approaches.

Most users rate the Wang hardware as very good, but indicated the usual number of mechanical problems. However, many were particularly impressed with the CRT terminal supplied by Wang, indicating that it was trouble free and well liked by operators.

Most were happy with the BASIC/Operating System combination. One user indicated that they were so tightly coupled, that new releases of system software by Wang presented no problems in implementing (as do system changes made by many other manufacturers). As one user put is, "Wang is so far ahead that the real problem is finding a programmer who can fully utilize the system's features."

Only four of the users interviewed had used other major computing equipment within their firms before using the Wang 2200MVP. When looking at computer equipment, the most frequently mentioned competition for the Wang were DEC and IBM (with five mentions each) followed by a variety of others including HP, DG, and NCR. Users of Wang felt that the major criteria for choosing a computing system were cost, service, ease of use, and availability of packages, followed by reliability, manufacturer's reputation, speed, and expandability.

The major negative comments about Wang dealt with the manufacturer/user interface, including service, documentation, and training. While the hardware support seems good, there were several comments that the sales and software service from Wang was deficient, including lack of initial training on how to use the system, and some unhappiness with system documentation. However, two users had attended the programming course offered by Wang and were very happy with it.

As usual, though some users were unhappy with various aspects of the Wang system, virtually all were, overall, very satisfied with the Wang 2200MVP. Typical comments included "Wang is a very good machine for the price," and "I've worked with the others and I still like Wang the best."

CONCLUSIONS

The Wang 2200MVP reviewed in this report is based upon the same 2200 series processor reviewed as the 2200VP in our Series 2 reports.

The benchmark timings indicate that the 2200MVP is a very fast computer. With up to eight terminals running there was an insignificant increase in response times, and the addition of a ninth terminal running a CPU intensive job made very little change in response. Also, the use of the multi-user MVP system did not seem to add system overhead when compared with the VP operating system.

Users were very satisfied with the hardware, particularly the 2236 series interactive terminal. Other than occasional mechanical problems with disks and printers, the major negative user comments concerned a lack of communication and support across the company/user interface. However, this problem seems to be abating as Wang catches up with the rapid growth of the past two years.

A unique aspect of the Wang 2200MVP is the interactive BASIC programming environment. Because program corrections can be easily made and the program re-run immediately, de-bugging is simplified and there is some indication that program development time is significantly reduced. Additionally, the interface between the programmer (or user) and the operating system consists of BASIC utility programs in the system library. Thus, there is little distinction between applications and system programming since both are imbedded within the same operating environment.

The majority of users surveyed were utilizing the 2200MVP for business applications. While third-party packages were being used, most users were doing some in-house programming and were very familiar with the system. They liked Wang's version of BASIC, and utilized the 2200's capability of using a "global" area of memory to pass information among programs.

In summary, the Wang 2200MVP utilizes a somewhat different approach in both its architecture and operating system. This, along with reliable equipment, makes it an easy-to-operate machine which appears to be very versatile.

NEXT ISSUE: IBM Series/1.

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To Hank

BENCHMARK REPORT/

ASSOCIATION OF COMPUTER USERS

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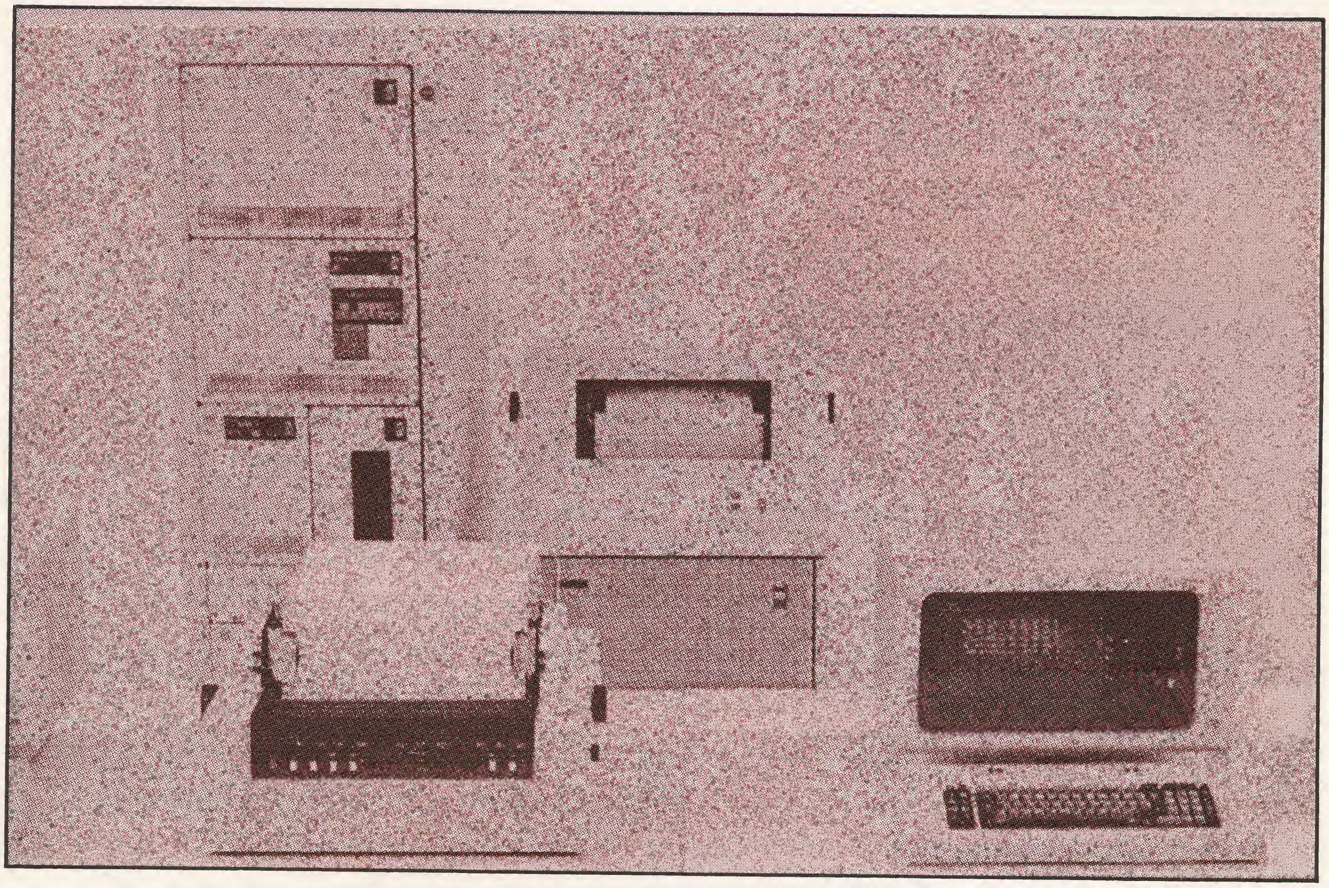

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The IBM Series/1

IBM SERIES/1: BENCHMARK REPORT

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PREFACE

In this, our third report covering multi-user computing systems in the $25,000 to $50,000 price range, we examine the IBM Series/1. The goal of this series is to provide users with comparative information on a number of systems for use in selecting from among the many alternatives available--information which is simply unavailable from any other independent source.

In evaluating computing systems, the technical specifications supplied by manufacturers are often difficult to interpret and are seldom comparable across different computers. The potential buyer needs to know how well the equipment performs in specific applications, and how that performance compares with other computing systems. Additionally, subjective factors such as ease of use, versatility, and support service must be considered as a part of the choice process.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The IBM Series/1 used in our report was configured with a 4955E central processor, 160K bytes of central memory, a 64 megabyte hard disk, an I/O expansion unit with a 4-line programmable communications card, a 4978 display station, and a 4973 line printer. Total system price is $52,375.

- Since 1969, IBM has "unbundled," or charged separately for, their their hardware and software. Thus, the price given above does not include any software. A "typical" multifunction work station application (using IBM's definition of typical) would require around $10,000 in additional software purchases. In most cases, though, users lease the system software from IBM (the $10,000 package would lease for about $175).

- The Series/1 could be described, in our view, as a "mini-mainframe." Though its architecture is new and not simply borrowed from other IBM equipment, from a user/programmer point of view, it's much like dealing with a scaled-down version of a IBM mainframe. We found that programmers who had experience on other IBM systems were quite comfortable programming the Series/1.

- In general, the users we contacted in our survey were very satisfied with the reliability and performance of IBM hardware. They had special praise for the Series/1's versatility, especially in the area of communications. Regarding software, the users were not nearly as enthusiastic, stating a number of complaints about the lack of sophistication of the EDX operating system and languages.

- We've priced out the system configuration made available to us by an IBM user, resulting in a price which exceeds our own $50,000 limit. Had we been able to "package" our own configuration suitable for this application, we would have been able to meet our price guideline.

- Our timings and extensive experience with the Series/1 reveal it to be a suitably fast performer. However, due to memory, software, and other technical limitations and problems with the configuration we tested (see the Benchmark Process), we were unable to get more than 4 ports to execute our order-entry system benchmark.

We found the IBM Series/1 to be a powerful and extremely versatile computer system. Its versatility and modular design allow the machine to be tailored to satisfy a wide range of user needs. Its corresponding complexity, however, implies that experienced, professional IBM Series/1 programmers are a necessity. To sum up, for most users, the Series/1 should be purchased as part of a complete, "turnkey" system from a reputable vendor. If not purchased in this manner, the user should have, or be willing to hire, experienced programmers who can take advantage of the versatility of the Series/1.

BENCHMARK REPORT

SYSTEM: IBM Series/1

PRICE AS TESTED: $52,375

SPEED TESTS

Benchmark Number	CPU INTENSIVE*	
A-8	N = 3000	4.9 seconds*
	I/O INTENSIVE	
B-4	N = 3000	23.1 seconds

"REAL LIFE" PROBLEMS

Benchmark Number	ORDER ENTRY	
D-1	2 terminals	7.9 seconds
D-2	4 terminals	8.0 seconds

D-3 and D-4 could not be run due to memory limitations.

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

	CPU-Intensive Program *	Order Entry Program

E-1 through E-4 could not be consistently run due to an apparent loss of characters in order-entry processing.

Note: Order Entry Program times represent average processing time per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

*Normally, A-4 (a program with square and square root) timings will be reported. The Series/1 does not have root functions in COBOL, so A-8 (using only multiplication and division) timings are given.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted IBM and requested their assistance in benchmarking the Series/1. IBM indicated they did not wish to provide direct assistance in this project, but would provide information and answer technical questions as they arose.

ACU located a Series/1 at a private user's facility in Boulder, Colorado, where we were given access to the machine at nights and during weekends. This system was configured with a 4955E central processor and 160K bytes of central memory, a 64 megabyte hard disk unit, a programmable 4-line communications card, a 4978 display station, and a line printer. Total cost of this system was $52,375. The software we used consisted of IBM's Event Driven Executive (EDX) operating system and utilities, and EDX COBOL. Monthly lease payments for this software would be approximately $110, with a purchase price of about $7,000.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, the North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the Series/1) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of one computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and 2 reports).

Benchmarking the Series/1

Unlike our experiences with other manufacturers covered in this series of Benchmark Reports, IBM chose not to provide us with any programming assistance or on-site technical support for benchmarking the Series/1. As a result, we were required to become familiar with the system, in depth, in order to run our benchmarks. We quickly discovered that the Series/1 is an extremely versatile machine, but as a consequence, extremely complex. This complexity, coupled with a variety of technical problems, caused us to spend many long nights over a period of several months to benchmark the Series/1.

As on all the computers we've tested in this series, it is necessary to generate the operating system (sysgen) in order to match its characteristics and capabilities with the particular hardware configuration to be used. On the Series/1, due to its enormous versatility, this is not a trivial task. The possible configurations are seemingly endless, and the process time consuming. Though the documentation on the Series/1 is extensive to say the least, it tended not to be problem-solving oriented (which is what we needed), but rather system design and application oriented. As we became more familiar with the system though, this process became less difficult.

Our order-entry benchmark program was written in EDX COBOL by a third-party programmer we hired for that purpose. Suffice it to say that our experience in debugging and correcting this program lends support to our advice in this and other Benchmark Reports to carefully choose your software designer/supplier.

Another problem area we encountered centered around the interaction between COBOL and the Series/1's Indexed Access Method (IAM). After much consternation (and some phone calls to IBM), it was discovered that the IAM installed at this site did not have the latest IBM-issued corrections. Upon installation of the corrected version, we at last were able to run more than one order-entry terminal at a time.

As is often the case in computer application programming, these problems did not occur sequentially, but rather were concurrent and interacting. After solving these problems, we were able to run multiple terminals, but

encountered additional difficulties when we attempted to run over 3 terminals.

As the order-entry program was originally designed, it would have allowed 6 terminals to simultaneously run. Unfortunately, for reasons as yet unresolved by either us or IBM personnel we contacted, our original program structure would not work for over 3 terminals. The program was redesigned, but the new version, which worked, took more memory. As a consequence, only 4, rather than 6, terminals could be run. An additional unresolved problem was a loss of characters in the order-entry program when we ran the CPU-intensive program in the background.

Our Observations

Despite what might appear to be a gloomy scenario from our benchmark testing, we were quite impressed with the Series/1 and its capabilities. Its versatility and modularity make it possible to tailor the machine for a variety of applications.

A feature we particularly liked and found especially useful given our inexperience with the system was a utility program called $SMMAIN. This utility allows the user to interact with the operating system via a menu-driven approach. The user need only select the utility or other operating system action desired and a "sub-menu" with necessary prompts is provided. $SMMAIN also "remembers" the last parameters the user set on any given "sub-menu," so that upon return, those parameters are displayed and need not be retyped. We found this especially useful during program development, when the programmer is in the edit-compile-link-execute cycle on one program.

A variety of utilities are included in the EDX operating system including various disk utilities and a full-screen editor. We found this editor to be quite powerful and very easy to use.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-8	Results:	N = 3000	4.9 seconds

Comment: *This time is for the CPU-intensive program using only multiplication and division. Therefore, this result should be compared to timings for Benchmark Number A-8 (not A-4) in our other series of reports.*

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,275 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average

run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	23.1 seconds

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order Entry Run in Production Mode

The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

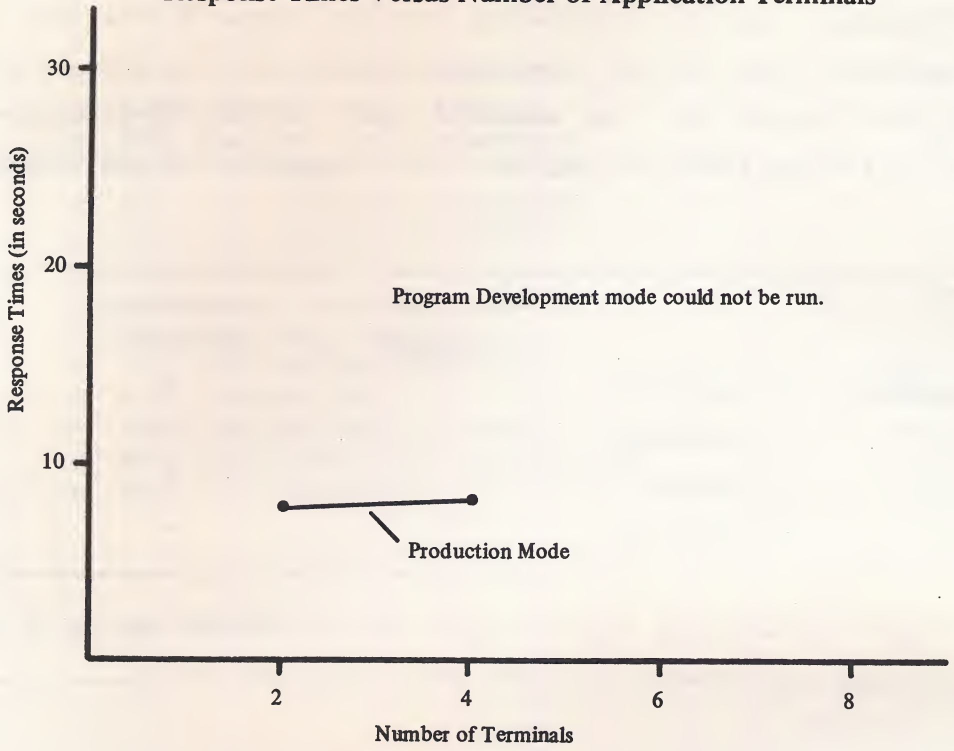
D-1	Results:	2 terminals	7.9 seconds
D-2		4 terminals	8.0 seconds
D-3		6 terminals	*
D-4		8 terminals	*

Comment: D-3 and D-4 could not be run due to memory limitations.

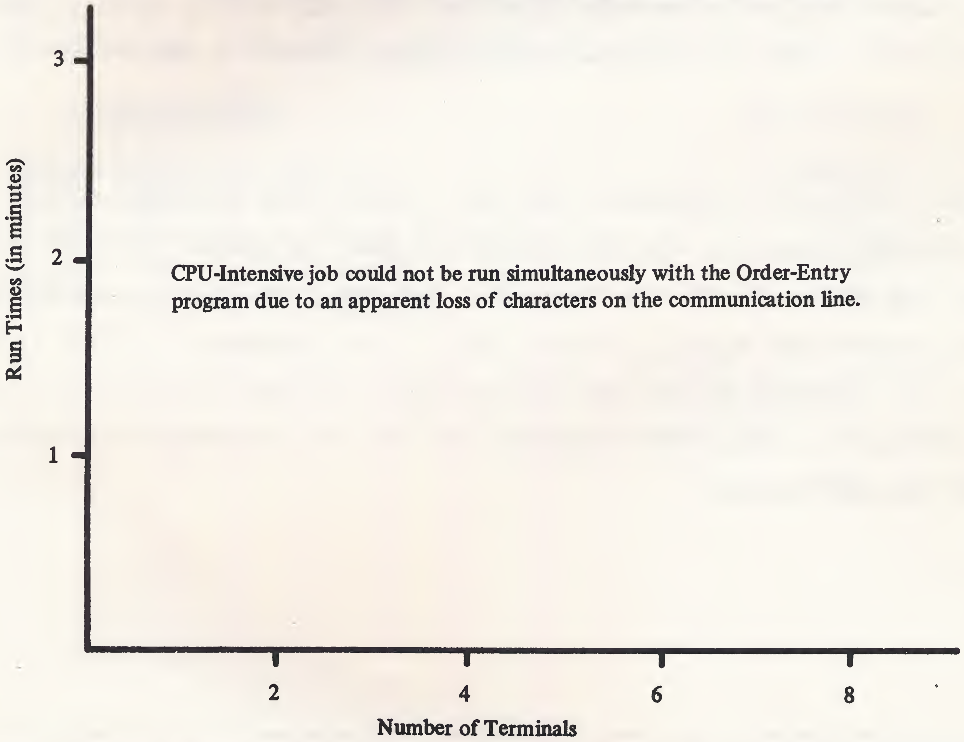
Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	*	*
E-2		4 terminals	*	*
E-3		6 terminals	*	*
E-4		8 terminals	*	*

*Comment: *Program development timings could not be obtained due to an apparent loss of characters in the order-entry processing.*

Analysis of "Real Life" Problem Results

The graph on the previous page illustrates the run times for the "real life" problem. The graph shows the time for the order-entry program for 2 and 4 terminals without the background program running (production mode). Note that doubling the number of terminals has little effect on the response times observed.

When we tried to run two terminals with the order-entry program, and an additional terminal running the CPU-intensive job, we seemed to lose characters between our RTE and the IBM Series/1. We were not able to establish whether the problem was with our COBOL application program, or with either the hardware or software of the Series/1. Since we have successfully completed the testing on four other systems, we felt it unlikely that the problem was with the RTE itself.

SYSTEM AS TESTED: IBM SERIES/1

Costs

• 4955 Processor-Basic Storage 64 KB	$12,120.00
• 32K Storage Addition	1,570.00
• 64K Storage Addition	2,535.00
• Programmable 8-Line Control	1,515.00
• Programmable 4-Line Adapter	1,725.00
• 4964 Diskette Unit Attachment	766.00
• 4978 Attachment	1,460.00
• 4963 Disk Subsystem Attachment	1,685.00
• 4973 Line Printer Attachment	987.00
• Programmer Console	507.00
• Communications Indicat. Panel	275.00
• Rack Mounting Fixture	59.00
• 4963 64MB Primary Disk Unit	11,760.00
• 4964 Diskette Unit	2,530.00
• 4975 Line Printer and Stand	9,109.00
• 4978 Display Station and Keyboard	2,327.00
• 4997 Rack Enclosure	1,445.00
Total System	$52,375.00

Our Observations

Additional terminals would probably be the 4979 display station (priced at $1,900 each) or the 3101 display station (priced at $1,360 each). The 3101 terminal is included in the prices below.

Configuration	Total Price
System with one terminal	$53,275
System with two terminals	54,635
System with four terminals	57,355
System with six terminals	60,075
System with eight terminals	62,795

All prices given above do not include software. A "typical" software configuration including the EDX operating system, utilities, Indexed Access Method, and EDX COBOL would cost about $110 per month to lease.

Summary of Equipment and Features

- The Series/1 offers two different processors, the 4952, and the 4955. With different processing speeds and options, the basic processors (without add-on memory) range in price from $4,600 to $12,120. The 4952 comes with 32K bytes of memory and can be expanded to 128K in 32K increments ($1,600 per 32K).
- The 4955 processor we tested comes with 64K bytes of memory (Model E) and can be expanded to 256K in 32K or 64K increments ($1,570 and $2,535, respectively). Optional features include a floating point feature which is a hardware/software addition that can be field installed and a programmer console ($507) which provides indicators and controls for programmer use. Also, a battery backup unit is available with automatic cutover if utility power fails ($2,060).

Our Observations

The 4955 is a capable 16-bit processor which was designed with communications handling in mind. The 4955 can have up to 256 individually addressed devices attached, many of which are controlled by their own microprocessors, reducing the load on the main processor.

A standard feature we particularly liked was the power failure detect/auto restart. In the event of a power failure, the system will automatically restart (in IBM's terms, the system will automatically IPL or perform an Initial Program Load).

Over half of the users we contacted were using the 4955 processor, with most of the rest using the 4952. Very few complaints about the processor were registered, although some users expressed a desire for increasing the memory on their system. Users were generally satisfied with the computational speed of the Series/1, though some users indicated they observed considerable slow-down during I/O handling. Except for one user who had a problem with a memory board, all of the users were very satisfied with the reliability of their central unit.

User Comments

- *With our interactive application, we sure could use more memory.*
- *The Series/1 is fast enough for our needs.*

STORAGE DEVICES

Summary of Equipment and Features

- The Series/1 offers disk, diskette, and magnetic tape storage devices. These include:

- 4962 Disk Storage Unit	Several models are available with capacities from 9.3 to 13.9 megabytes. One diskette drive may optionally be included ($7,600 to $11,300).
- 4963 Disk Subsystem	Eight models are available, with capacities from 23 to 64 MB. With 3 expansion units attached, total capacity for one subsystem can be 258MB. Additional subsystems can be attached to the Series/1 (prices start at $11,000 for 23 MB).
- 4964 Diskette Unit	A 606KB single drive unit ($2,600).
- 4966 Diskette Magazine Unit	Can hold up to 23 diskettes giving the unit a total capacity of 27 .8MB ($5,185).
- 4969 Mag Tape Subsystem	These tape drives offer 45 and 75 IPS speeds at densities of 800 and 1600 BPI. Up to four drives are available on a system ($10,000 and up).

Our Observations

The 4963 disk which we used in our tests uses multiple, nonremovable magnetic disks with movable heads for recording and retrieving data. The subsystem attaches to the Series/1 through a microprocessor-based attachment which can be plugged into either a processor or a I/O expansion unit.

Over half the users we contacted in our survey were using the 4962 disk system. Most were quite satisfied with their storage system, although when hardware problems were mentioned, it was in this area that problems did occur.

User Comments

. *This disk storage is like the System 34 - extremely cost competitive.*

. *More than adequate . . . have all the disk capacity I need. And I can expand when I need to.*

Summary of Equipment and Features

- The Series/1 offers four different display units that present a variety of CRT screen sizes and keyboard configurations. Each device is controlled by its own external microprocessor contained on an I/O feature card that plugs into the CPU I/O channel. Prices run (with attachment) from $1,300 to $5,300.

- Three different printers are offered. Two table-top matrix printers with speeds up to 120 cps are available for about $4,100, and the 4,973 line printer for $9,100 (Model 1).

- Communications options include an I/O expansion unit ($2,770) which provides space for an additional 24 I/O cards, a sensor I/O unit ($1,800) which provides space for up to eight sensor feature cards, and a teletypewriter attachment card which allows Series/1 communications with Teletype devices ($600).

- The 4987 Programmable Communications Subsystem is also available ($4,300 to $18,000, depending on configuration). This programmable multiplexer provides attachment and control facilities for up to 32 lines. Multiple 4987 units may be contained in a single Series/1 system.

Our Observations

In our tests, we used the 4978 display station, and were quite impressed with this "smart" terminal. Features like programmable function keys, separate numeric and cursor control pads, and good typing "feel" made this an enjoyable terminal on which to work.

Unfortunately, neither we or the users we talked with can be as generous regarding the 4973 line printer. Though generally regarded as reliable, complaints included paper loading difficulties, too much noise, and general dissatisfaction.

User Comments

- *The 4978 is great . . . it has an excellent feel.*
- *The 4973 is not up with the other products on the market.*
- *The 4973 is difficult at best to load . . . sometimes I'd just like to throw it out.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- The Series/1 offers two operating systems, both intended for multiterminal, multitasking and multiprogramming applications:

- Realtime Programming System	Intended for the experienced IBM user, this system offers a complete range of I/O support.
- Event Driven Executive (EDX)	This system is intended for the smaller, less experienced user who needs an entry-level system that can expand as needed. Price of this system starts at $16 per month.

Our Observations

As is true of the hardware for the Series/1, system software is also highly modular. The number and types of modules to be purchased by a user are a direct function of the particular application to be implemented.

The Event Driven Executive operating system consists of a set of five licensed programs which include:

• Supervisor and Emulator	- a multiprogramming system supervisor. It supports a variety of applications and provides an operating environment for FORTRAN, COBOL, PL/1, EDL, and a macro assembler.
• Utilities	- a variety of utilities including data set management, interactive debugging, and a full-screen editor.
• Program Preparation Facility	- allows the user to compile and link edit application programs (written in EDL)
• Macro Library	- used in conjunction with the macro assembler.
• Macro Library/Host	- provides the capability to assemble programs for the Series/1 on a host System/370.

Additional offerings that run under EDX include:

- EDX Math and Functional Library - a library of commonly used math and data conversion routines.
- EDX Indexed Access Method - a data management facility for indexed file operations
- EDX Multiple Terminal Manager - a set of high-level functions designed to simplify development of transaction-oriented applications.

During our lengthy experience with the EDX operating system, we became particularly fond of the session manager utility. This utility provides a menu-driven approach to the operating system with automatic allocation of the necessary user work files. As one becomes more familiar and comfortable with the system, session manager may be used to a lesser extent, but we found it to be extremely helpful in learning the intricacies of the EDX system.

As we've stated before and now re-emphasize, the Series/1 is a complex machine requiring a great deal of resource management by the user (unless, of course, it is bought as a "vendor-packaged" system). The user must (not just may, but must) control such things as determining priorities of programs in the machine, allocating file sizes, types, etc. as there is no dynamic file allocation, and scheduling the printer among the various users on the system. At the time of this writing, IBM has just released some enhancements to EDX to help alleviate these difficulties including SPOOLing (to allow multiple-user access to the same printer) and improved file allocation methods.

System generation on the Series/1 is also a non-trivial process. Though the possible configurations for the system are nearly endless, a relatively complicated process is involved in building a "personalized" system. A major difficulty we encountered involved the fact that the user is required to know what software modules or components are required in the operating system to match the specific hardware configuration.

Well over half of the users we contacted in our survey were using the EDX operating system. Their comments were generally positive, though not overwhelmingly enthusiastic. Though most felt that EDX was a "good" system, they often berated its lack of sophistication.

User Comments

- *EDX is not a terribly sophisticated system . . . but it gets the job done.*
- *The way it handles data sets is awkward. They need improved allocation methods.*
- *The Series/1 system software is two years behind the hardware.*

Summary of Features

- The EDX operating system offers EDL, PL/1, FORTRAN, and COBOL with prices starting at about $20 per month.
- The Series/1 also offers some packages useful for the design and implementation of user application programs. These include

- Host Preparation Facility	Allows the user to prepare Series/1 programs on a 370 and transmit them to a Series/1 for subsequent execution.
- Waterloo Interactive Direct Job Entry System	A multiuser text editor and batch job submission facility.
- Series/1 Debugging Aid	An assembler language debugger.
- Waterloo Basic Compiler	Intended for educational institutions, this is an interactive, multiuser BASIC program.

Our Observations

In our benchmark order-entry application, we used EDX COBOL. We found it to be a basically standard version of COBOL without a great deal of enhancements. This relative simplicity does make this version of COBOL highly transportable with other machines.

As is common with many COBOL compilers, a great deal of code is generated by the EDX COBOL compiler. Due to the resultant large size of our order-entry programs, we could not load over four copies into our 160K system. Had this application been programmed in EDL, we're certain that program size would have been much smaller so that eight terminals may have been concurrently run.

From our experience, we believe EDL (under the EDX operating system) would be our "language of choice" for the Series/1 due to its greater ability to capture the versatility of the system. Six of the users we contacted were using EDL and generally agreed with our assessment, rating EDL "good." Of the four users programming in COBOL, only one rated it "good" while the others rated it "fair" or "very poor."

User Comments

- *I wish the COBOL was better enhanced.*
- *I think you can do a lot with EDL. My only complaint is that though it makes efficient use of the machine's time, I can't say the same for programmer's time.*

Summary of Features

- IBM offers an enormous amount of documentation on the Series/1. Nearly all aspects of the Series/1' hardware and software are covered in the several hundred pieces of documentation available.
- IBM also offers a number of training courses covering a variety of information regarding the Series/1. Courses on both operating systems, languages, communications interfaces, and other topics are offered.
- IBM offers a 9 hours per day/5 days a week maintenance contract as well as a 24 hour/7 day service. In addition, a toll-free "hot-line" is available for user questions.
- There is an IBM-sponsored users group called COMMON. The group's activities include publication of a newsletter and various presentations and meetings.

Our Observations

The documentation on the Series/1 is extensive to say the least, and nearly as complex as the machine itself. We found that one must really learn not only their way through the system's capabilities, but also through the system manuals which document those capabilities.

In our contacts with IBM sales and technical personnel, we found them to be very helpful and knowledgable. IBM technical reps were often able to pinpoint our problems over the phone. The users we contacted generally reported similar experiences with IBM service people, especially in the area of hardware service. Software service and support was not always as well received.

User Comments

- *I could use more software support from IBM.*
- *IBM's hardware service is excellent.*
- *The good thing about the Series/1 is it has the IBM name . . . lots of support behind it.*
- *IBM people are always willing help.*
- *I've gotten zero software support from IBM . . . they can't answer my questions.*

SUMMARY OF USER COMMENTS

Using names supplied by the Association of Computer Users, we contacted 15 users of the IBM Series/1. This system is being used in a variety of applications from engineering applications to standard business applications to production process control applications.

About half of the users we contacted had used the Series/1 for less than a year, while the rest had used their system for one to two years. Typical configurations consisted of either the 4952 or 4955 processor, the 4962 hard disk, the 4974 matrix printer, and the 4978 display stations. Other features being used included the 4966 diskette magazine, add-on 4979 display stations, a card reader, and various communications features.

These users showed the Series/1 to be a hard working machine with nearly all reporting no less than 5 hours per day utilization of their system, with over half saying they used their machine more than 8 hours per day. Most users had from three to six terminals attached to their system, but one user reported ten while another twelve terminals.

Uses of the Series/1 included the standard accounting applications such as payroll and receivables. In addition, the system was being used for remote data entry, lab automation, systems software development, pharmacy inventory and patient record storage, inspection machine control, and refinery control. About half of the users had a sufficiently large business to support their own in-house programming staff for the Series/1, while the other half utilized third-party programmers for their applications. As one user put it, "as far as programming the Series/1 is concerned, I wouldn't recommend it for a small shop."

Both the Realtime Programming System and the Event Driven Executive operating systems were being used. Though in general users were satisfied with the operating system, a number of users expressed unhappiness with their system. Some of their comments included: "EDX is not a terribly sophisticated system," "They need a wholesale revamping of the operating system," and "IBM never told me about all the modifications I'd have to make to the operating system to get it to fit my hardware."

EDL, COBOL, FORTRAN, and Assembler were the main programming languages of the users we surveyed. EDL and Assembler were highly rated, though the difficulties of programming in EDL led one user to say that "EDL makes efficient use of the machine, but not of programmer time." FORTRAN was generally rated "adequate" while few users were happy with the Series/1' COBOL, rating it "very poor" or "fair."

Users seemed to be mixed in their assessment of IBM software support on the Series/1. Many users felt they received good support for their IBM software, while some were very unhappy with IBM responsiveness. Positive comments included "IBM service on the operating system software is excellent" and "IBM people are always willing to help." Negative comments included "I get zero support from IBM . . . they can't answer my questions" and "IBM was not very responsive when I had COBOL problems . . . I think they misrepresented the capabilities of their COBOL."

In the area of hardware support and service, users were very satisfied. Though few hardware problems were reported, when they did occur, service was rated from "good" to "excellent." As one user put it, "the best thing about my machine is it has the IBM name on it . . . there is a lot of support behind it."

The most frequently mentioned alternatives to the Series/1 were DEC, HP, Burroughs, Data General, and Honeywell. Other equipment evaluated included NCR, Univac, Prime, TI, Apple, and Pertec. The most important factors in their selection of a computer system were hardware reliability, cost, and versatility or modular design.

In summary, the users we contacted in our survey gave us the impression that they were, overall, quite happy with their Series/1. They were delighted with the communications features and versatility of the machine, although a good deal of dissatisfaction with system software was expressed. Perhaps their feelings about the Series/1 are best expressed by this comment from a user, "The Series/1 is an honest piece of machinery. It does what they say it will with a high degree of reliability. It's like a Caterpillar (tractor) . . . a basic piece of machinery that you just can't fault."

CONCLUSIONS

In this report we've examined the IBM Series/1. Though our benchmark timings are incomplete due to some technical problems, we feel we've learned a great deal about this machine in the large amount of time we have spent with it. A "mini-mainframe" as we've described it, the Series/1 appears to the user/programmer much like a large IBM mainframe.

The Series/1 is an extremely versatile machine, whose modular design in both hardware and software give the system great flexibility and an enormous number of possible hardware/software configurations. This versatility does not come "free," however. In exchange for a highly adaptable machine, the price of great complexity is paid. The Series/1 requires a lot of resource management by the user, it's not automatic.

It is for this reason that we found in our user survey the Series/1 being used with great success by basically two types of users. One type consisted of the user who bought the Series/1 as a "turnkey," packaged system from a vendor. The other type was a relatively large firm with a competent staff of programmers familiar with IBM equipment. As one user stated, "It's an easy machine to use . . . if you have the software developed for it."

The users we spoke to were, in general, quite satisfied with their Series/1. They were very enthusiastic about the high degree of hardware reliability they were experiencing, with over three quarters of the users we contacted indicating over 8 hours per day, 7 days per week trouble free utilization.

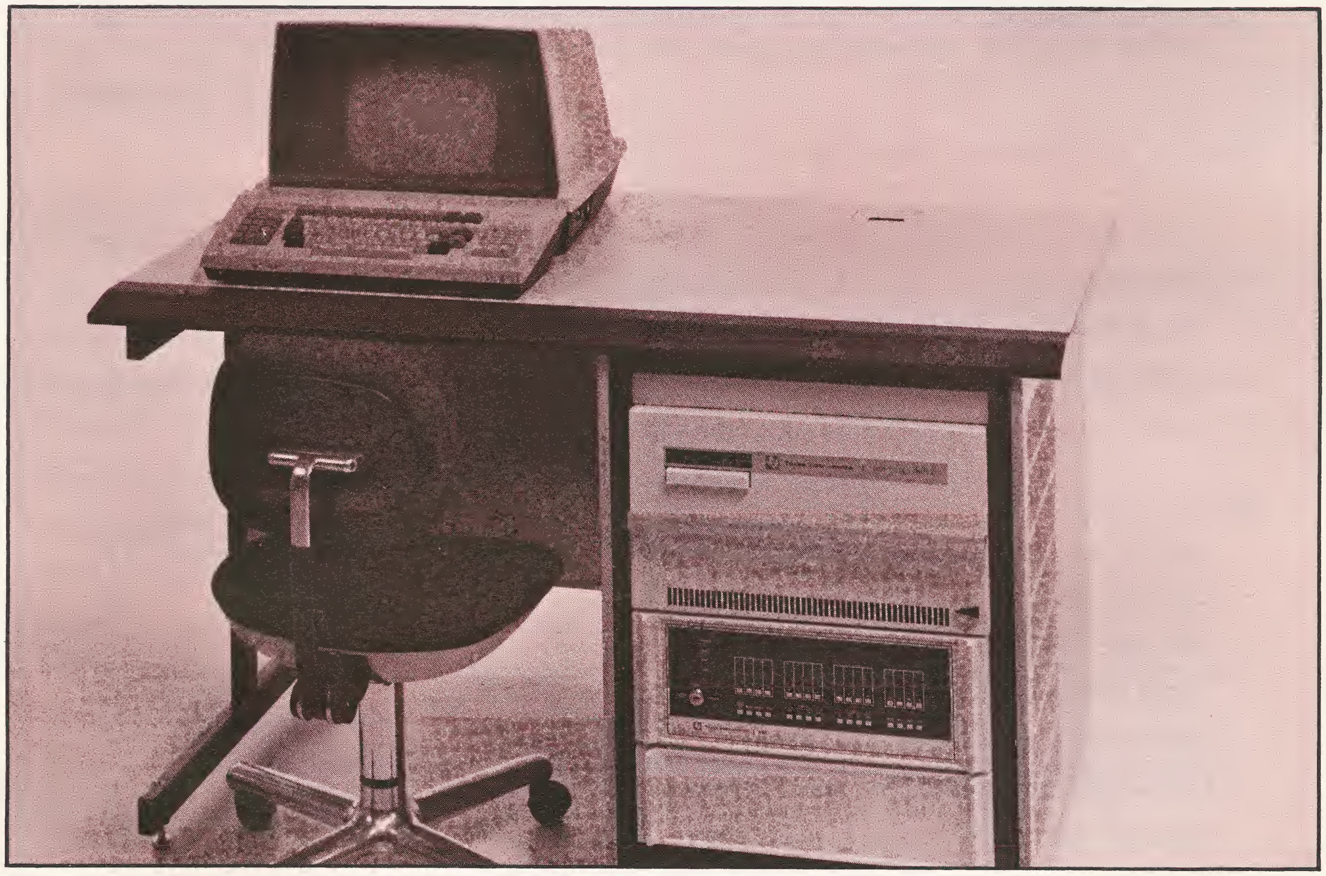
As we have often seen to be the case, the negative comments we did receive were primarily in the area of software. Our own experience during the benchmark process with Series/1 programmers and the consensus of users we talked to would indicate that experienced, competent programmers are a necessity for software satisfaction with the Series/1.

Released four years ago as a special-purpose machine (especially in the area of communications), even the giant IBM must go through a break-in period with the new architecture and software of the Series/1. As the system is refined over time, the Series/1 is becoming a powerful competitor in the minicomputer marketplace.

BENCHMARK REPORT

ASSOCIATION OF COMPUTER USERS

VOLUME 3.2, NUMBER 4, OCTOBER 1980



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The Texas Instruments DS990 Model 4

TEXAS INSTRUMENTS DS990 MODEL 4: BENCHMARK REPORT

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PREFACE

The Texas Instruments DS990 Model 4 is the fourth mini-computer to be evaluated in this series of reports covering multi-user systems in the $25,000 to $50,000 price range. The comparative information provided by this series of reports will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source.

We have found that the technical specifications supplied by manufacturers are difficult to interpret, and often misleading in terms of how systems behave in an application environment. Potential users need to know how well equipment performs in specific applications and how that performance compares among alternative systems.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order-entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Texas Instruments DS990 Model 4 used in our benchmark tests consisted of the 990/10 processor with 256 kilobytes of central memory, a 9.4 megabyte hard disk, eight TTY/EIA terminal interface modules, a 911 video display terminal, a 150 character per second printer and the DX10 operating system. Total price of this system as tested is $36,635 (a total of eight terminals would bring the price to $46,355).

- In addition to the COBOL version of the order-entry benchmark, whose times are featured in this report, we also tested FORTRAN and Pascal versions. All three versions performed well with the Pascal version turning in the fastest timings while the FORTRAN was slowest.

- The DX10 operating system that comes with the Model 4 "package" is a powerful, multi-task, multi-terminal system. Its menu-driven approach via the System Command Interpreter makes learning and using this complex system unintimidating for the novice or less-experienced user. Through the use of procedure files and direct command entry, the experienced user can avoid the menu hierarchy and save time and effort.

- The users we contacted in our survey had only good things to say about the Model 4. Their praise covered all aspects of the system, but special plaudits were given to the "human-interfacing" of the operating system and the reliability of TI equipment. TI service, when necessary, was also applauded for its quick and efficient response.

- TI does not sell application software, but does offer application program development tools including a forms package and a database management system. An extensive line of OEM's does insure a wide offering of applications packages for the Model 4.

- Through use of a memory mapping feature, central memory on the Model 4 can be expanded up to 2048 kilobytes. Combined with efficient memory management on the part of the DX10 operating system, the Model 4 can accommodate multi-terminal applications with ease. Several users we contacted reported using 8 to 10 terminals on their system with one user reporting 15 to 20.

- One of a family of DS990 systems, the Model 4 comes with a 9.4 megabyte hard disk drive. Models 6 and 8, which also employ the 990/10 processor, are packaged with 44.7 megabytes and 89.2 megabytes respectively. The user is not restricted to these packages, though, and may in fact configure a system to meet individual data processing needs.

The fourth system to be evaluated in our benchmark reports, the Texas Instruments DS990 Model 4 proved itself to be a powerful performer in our multi-terminal minicomputer tests. Universally applauded by the users we surveyed, the DS990 is a versatile system capable of serving the data processing needs of business.

BENCHMARK REPORT

SYSTEM: TI DS990 Model 4

PRICE AS TESTED: $36,635

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE*	
A-8	N = 3000	110.3 seconds
	I/O INTENSIVE	
B-4	N = 3000	47.0 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	3.8 seconds
D-2	4 terminals	3.9 seconds
D-3	6 terminals	4.0 seconds
D-4	8 terminals	4.3 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program *	Order Entry Program
E-1	2 terminals . .	116.1 seconds	3.9 seconds
E-2	4 terminals . .	122.9 seconds	4.0 seconds
E-3	6 terminals . .	128.8 seconds	4.1 seconds
E-4	8 terminals . .	135.2 seconds	4.3 seconds

Note: Order Entry Program times represent average processing times per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

* *Normally, A-4 (a program with square and square root) timings will be reported. The TI does not have root functions in COBOL, so A-8 (using only multiplication and division) timings are given.*

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Texas Instruments and requested their assistance in benchmarking the DS990 Model 4. We requested that the total system be priced in the $25,000-$50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 price limit, we advised TI that we would report the cost over-run, but would continue to benchmark the computer using up to eight terminals.

Texas Instruments provided us with a DS990 Model 4 at their office in Denver, Colorado. The system consisted of a 990/10 processor with 256 kilobytes of main memory, a 9.4 megabyte fixed/removable hard disk, 8 terminal interface cards, a video display terminal, a 150 cps printer, and the DX10 operating system. Total price of the system was $36,635. DX10 COBOL used in our tests would add $3,200 to the price of the system.

TI also provided us with extensive programming and other on-site technical support for our benchmark.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, the North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the DS990) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of one computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stop-watch (as in our Series 1 and 2 reports).

Benchmarking the DS990 Model 4

Approximately 30 hours over two days were required to benchmark the Model 4. Upon arrival on the first day, communications were quickly established between the RTE and the Model 4 and testing of the first version of the order-entry system (the FORTRAN version) was begun. All went smoothly up to this point, and as programmers are often apt to do, we assumed that if this worked, all the rest of our versions would also work. Unfortunately, this was not to be the case, and an additional 20-odd hours were required. In all fairness, though, the additional time was required primarily because we tested three different versions of the order-entry program (FORTRAN, COBOL, Pascal), instead of our usual one. With the help of TI personnel, all the program "bugs" were worked out and the benchmark process was successfully completed late the second day.

Our Observations

Our order-entry benchmark program was written in three different languages by TI personnel. This variety, though magnifying the amount of time necessary to perform the benchmarks, gave us a very good opportunity to see the DS990 in "action" during program development mode. As our experience with minicomputers in the \$25,000 to \$50,000 range grows, we've become particularly sensitive to the human engineering or human interfacing qualities of the systems we test. In this area, we were quite impressed with the DS990.

DX10, the operating system that makes the 990 a "computer," is a powerful, versatile system that is not intimidating. Its interactive menu-driven mode, called the System Command Interpreter (SCI) by TI, prompts the user for the required information, making it very easy to learn the system. Using a hierarchy of menus, the inexperienced user can be led to the procedure required, while the experienced user can save time by directly entering the required command. As must be obvious by now, we feel that on a system where the operating system is not "imbedded" in the program development environment (as is the case with the TI), a menu-driven approach to the operating system is an essential ingredient for comfortable human interfacing.

Other features we enjoyed on the Model 4 included the text editor, which we found efficient, powerful, and easy to use, the terminal keyboard with its separate numeric and cursor control pads, and the easy-on-the-eyes green

phosphor screen. We also liked TI's command file capability called PROC's. These "procedure files" give the user the ability, using SCI primitives, to create personalized procedures or utilities. With the use of loops, counters, and IF checks, the user can create powerful procedures.

Personalizing the DX10 operating system is accomplished with an interactive program which prompts the user for the necessary information (GEN990). The system is then assembled and linked with another command. This process appears relatively straightforward, and the interactive approach is helpful, but it can be time-consuming. Though the "normal" system generation procedure should take less than a half hour (not including time spent on the interactive portion), additional time must be spent "patching" the system. These patches, which are corrections and modifications to the operating system made by TI, must be inserted in the assembled operating system. Depending on the number of patches to be inserted, this process can take an additional 30 minutes or more. Though system generation is not an oft repeated process, we've found that we appreciate systems whose "sysgen" process is fast, thus allowing quick configuration changes when needed.

The structure of the order-entry programs used in our benchmark tests varied depending on the language used. The COBOL version, featured in this report, occupied a total of 168k bytes in our 256k machine. COBOL on the DS990 could be described as "semi-compiled" in that the compiler produces intermediate code which is operated on by a run-time interpreter. Using shared code, eight terminals required 11K per terminal plus 80K for COBOL run-time and the operating system. Though not interpretive, the Pascal version of the order-entry program was similarly structured. The FORTRAN version showed the most degradation as terminals were added. This was due to its structure of separate copies of the program being required for each terminal. Thus, multiple copies of the program combined with the operating system used up available memory and forced the system to perform roll-in/roll-out, a time consuming disk I/O process.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A - 8	Results:	N = 3000	110.3 seconds

Comment: *This time is for the CPU-intensive program using only multiplication and division. Therefore, this result should be compared to timings for Benchmark Number A-8 (not A-4) in our other series of reports. CPU-intensive program A-4 was run in FORTRAN and Pascal yielding times of 49.7 and 54.2 respectively.*

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following

3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	47.0 seconds

Comment: The FORTRAN timing was 57.2. The Pascal timing is not available.

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

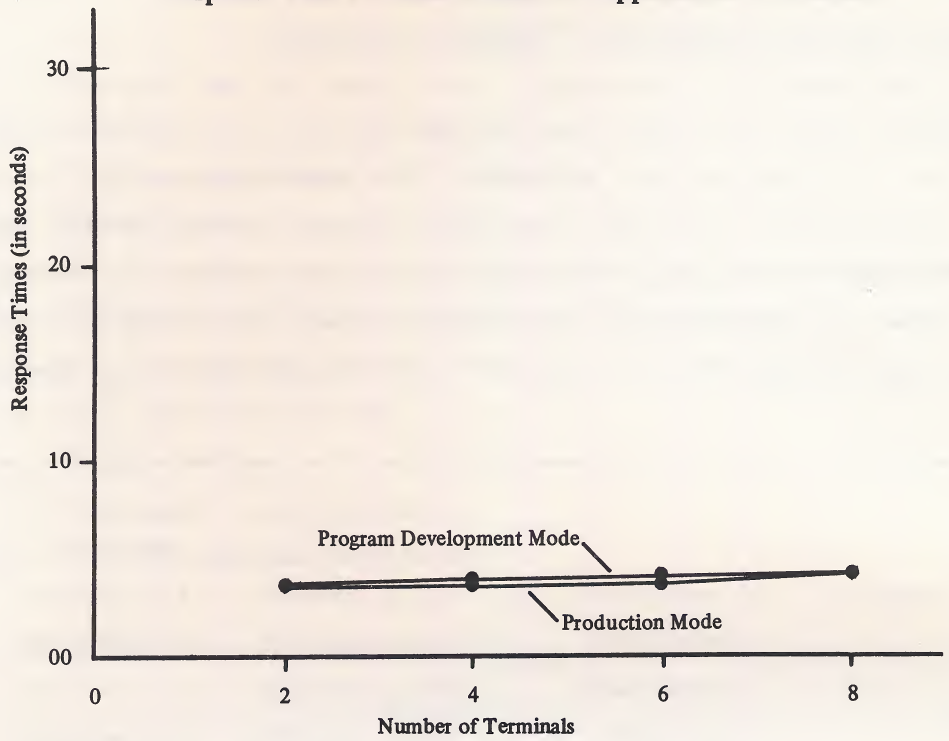
Order Entry Run in Production Mode

The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

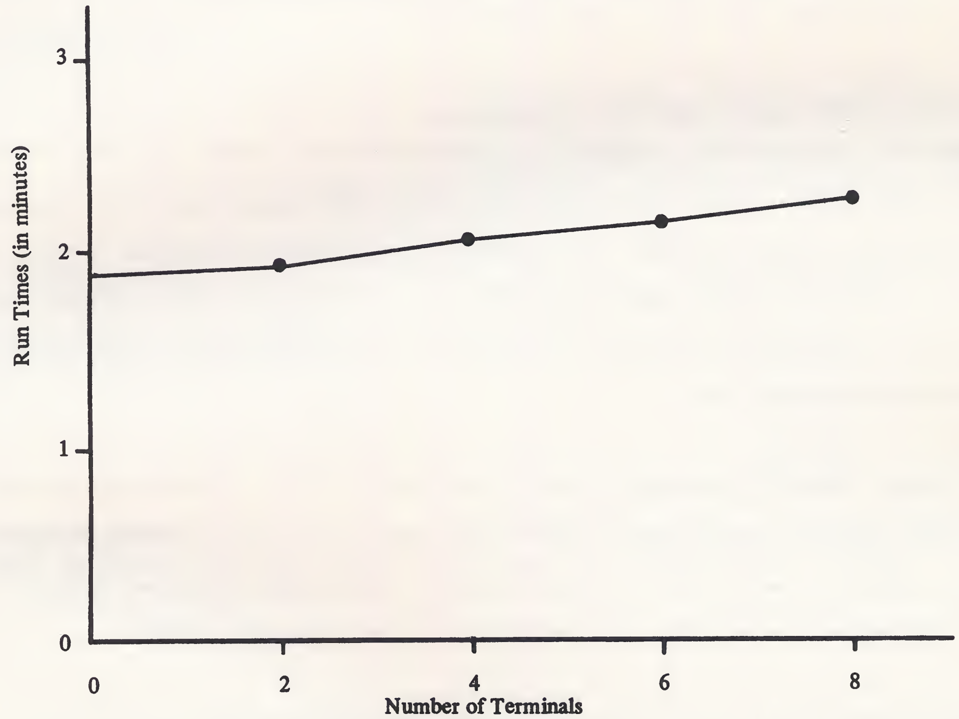
D-1	Results:	2 terminals	3.8 seconds
D-2		4 terminals	3.9 seconds
D-3		6 terminals	4.0 seconds
D-4		8 terminals	4.3 seconds

BENCHMARK TIMINGS: TI DS990 MODEL 4

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



Comment: FORTRAN and Pascal timings were 3.7, 4.0, 4.2, 4.8 and 3.4, 3.5, 3.6, 3.7 respectively.

Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	116.1 seconds	3.9 seconds
E-2		4 terminals	122.9 seconds	4.0 seconds
E-3		6 terminals	128.8 seconds	4.1 seconds
E-4		8 terminals	135.2 seconds	4.3 seconds

Comment: The FORTRAN version yielded these timings: 52.6/3.8, 56.1/4.0, 61.9/5.0, and 65.7/7.8 while the Pascal timings were 58.2/3.4, 61.4/3.5, 64.6/3.7, and 68.1/3.9.

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for 2, 4, 6, and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-Intensive job.

In all cases, adding terminals slows response times. The FORTRAN version displays the most degradation, while the Pascal version displays the least. The COBOL version, with its unique program structure, showed almost no degradation in response times when the background program was added.

SYSTEM AS TESTED: TI DS990 MODEL 4

Costs

The Model 4 as configured for our benchmark tests consisted of the standard Model 4 package plus a printer and interface cards:

Standard Model 4	$30,250

- 990/10 minicomputer with mapping
- 256k bytes of central memory
- 13-slot chassis with programmer panel and disk loader ROM
- 911 Video Display Terminal with dual controller
- 9.4 megabyte fixed/removable cartridge disk drive
- DX10 operating system
- Single or double bay desk with cabinet

Model 810, 150 cps matrix printer	$ 2,705
(8) TTY/EIA Terminal Interface Modules	$ 3,680
Total System	$36,635

Our Observations

Additional 911 terminals are priced at $3,950 for two terminals and a dual controller. The first additional terminal will not require a controller due to the Standard Model 4 package containing a dual controller. Also, the TTY cards would not be required, so the following totals do not have the cards priced in.

Configuration	Total Price
System with one terminal	$32,955
System with two terminals	34,505
System with four terminals	38,455
System with six terminals	42,405
System with eight terminals	46,355

Included in all these prices is the DX10 operating system. The DX10 COBOL featured in our tests would cost an additional $3,200.

Summary of Equipment and Features

- The Model 4 uses TI's 990/10 16-bit minicomputer. The processor is contained on two circuit boards which are housed in a 13-slot chassis. The version we tested employs a 1k byte EPROM program loader which can load from diskette, disk, mag tape, cassette, or card reader. Some of the features of this processor include a real-time clock, integer hardware multiply/divide, power fail/auto restart logic, and a CRU bus for decoding up to 4096 input and output lines.

- The 990/10 processor with mapping has a total memory capacity of 2048k bytes. The standard Model 4 comes with either 128k or 256k bytes of central memory. Additional modules may be purchased with 64k costing $2,000 and 128k costing $3,500. Cache memory is also available on the DS990 computers.

- Other options include a programmer panel (included in the price of the chassis) that provides the ability to load and read registers and memory, and a standby power supply ($780).

Our Observations

The 990/10 processor features a mapping capability that allows the user to employ a very large amount of central memory (up to 2048k). This capability would be extremely useful in multi-user applications. TI's error-correcting memory, though more expensive than standard parity memory, provides for 1-bit error correction and two-bit error detection, using a 6-bit Hamming code with each 16-bit word. TI states that this type of memory should dramatically reduce the number of system failures in large memory systems.

Cache memory systems are available on the Model 4. Employing a 2k byte high-speed buffer, the cache operation is automatic and invisible to the programmer. Though available on 990/10 processor systems, TI notes that greater performance improvement would be noted with their 990/12 processor.

Users were in general satisfied with the performance and compact size of their computer. Most users reported that the speed of their system was good, though some were less enthusiastic. However, users' impressions of the speed of the central processor are, as is nearly always the case, a function of the whole system (input/output devices, software, etc.) and not simply the processor.

User Comments

- *It's very, very compact.*

- *I'm impressed with the fact that we're not locked into size . . . the TI has it over the IBM in that we can expand.*

STORAGE DEVICES

Summary of Equipment and Features

- The TI DS990 Models 4, 6, and 8 are all systems which are based on the 990/10 processor. They differ only in the hard disk drive system included in the package. The Model 4 uses a single DS10 10mb drive, the Model 6 uses dual DS25 drives with a total capacity of 44.7 megabytes (the Model 6 is $21,250 more than the Model 4), and the Model 8 uses dual DS50 drives with a total capacity of 89.2mb (for $26,250 more than the Model 4).

- The number of drives that can be put on a DS990 system is only limited by the number of slots available in the chassis for the disk controller boards. The DS10 controller will accommodate 2 DS10 drives ($11,400 for dual controller and one drive, $8,600 for an additional drive). The DS25 and DS50 controllers will drive 4 units (the DS25 controller and drive costs $17,000 with additional drives costing $11,795 each, while the DS50 controller and drive is $19,200 with additional drives costing $14,600 each). Each type of disk controller occupies one slot in the chassis.

- The DS200 169 megabyte disk is also available at a cost of $31,500 including a four-drive controller. Additional drives cost $25,500 each.

- TI also offers a magnetic tape transport in nine-track 800 and 1600 bpi versions. Price of the transports are $11,100 and $12,775 for the two versions respectively (includes controller).

- Diskette storage is also available for the Model 4 with two different drives available.

Our Observations

As is apparent, the on-line disk storage capability of the DS990 is enormous for this size of computer system. The DS25, DS50, and DS200 all use removable disk packs, so the amount of off-line storage is only limited by the number of packs a user wishes to maintain.

The majority of users we surveyed were using one or more DS10 drives. They were quite satisfied with the performance of their drives and reported few problems. Users were particularly pleased with the easy back-up capability provided by the removable disk cartridge on the DS10.

User Comments

. *It's very easy to make daily backups.*

. *No problems.*

Summary of Equipment and Features

- The 911 Video Display Terminal consists of a 24 line by 80 character CRT which uses a 96-character ASCII alphabet with upper and lower case and a detached keyboard with separate cursor and numeric pads. The 911 includes full cursor control, three programmable levels of intensity, and ten programmable function keys. The 911 with dual controller costs $2,400 and an additional terminal will add $1,550.

- Three hardcopy terminals are available including two that use TI's Silent 700 thermal printer.

- The 810 printer that we used in our tests is a tabletop, 132 column, 150 character per second matrix printer. Featuring bidirectional printing and buffered reception, the 810 with interface is priced at $2,705. Models 2230 and 2260 line printers are also available, offering 300 lines-per-minute and 500 lines-per-minute printing speeds respectively. The 2230 costs $13,500 and the 2260 $18,250.

- The Model 804 card reader is also offered for DS990 systems. The 804 will accommodate standard-size 80-column cards that are read at a 400 card-per-minute rate.

- A variety of communications interfaces are available on the DS990. Offerings include EIA-standard RS232C interfaces, digital/analog converters, and others.

Our Observations

We found the 911 VDT to be an excellent, "comfortable" terminal, as our previous experience with TI terminals had led us to expect. We've always enjoyed the layout of TI keyboards with their separate cursor and numeric pads, and like the "feel" of the keys. The detached keyboard makes it easy to get comfortable at the terminal, and the green-phosphor screen is very easy on the eyes. We've also used the 810 printer before, and have always appreciated its quality and durability.

The users we talked to were, like us, quite happy with their TI terminals and printers. They liked the keyboard features, and most felt that the 810 printer, for its price, was one of the best on the market.

User Comments

- *I like the detached feature of the keyboard . . . and the number pad to the right.*

- *The keyboard is easy to work, and the output is rapid.*

- *Overall, it's probably one of the better printers in its price range.*

- *We love the printer; it's easy to align and compared to others it's very simple to operate.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- Included in the Model 4 package price is the DX10 operating system. Standard components of this operating system include the DX10 system executive, logical I/O support, interpreter for interactive and batch operation, and utilities such as a text editor, macro assembler, link editor, and debug package. Also included are file management utilities for sequential, relative, and multi-key-indexed files.

- DX10 supports a variety of languages and development packages including COBOL, RPG II, BASIC, Pascal, FORTRAN, TIFORM, TIPE-990, DX10 TPL, DX10 Sort/Merge, DBMS-990, Query-990, and DX10 3780/2780 Emulator.

Our Observations

The DX10 operating system included in the DS990 package we found to be a powerful, flexible system. As we stated before, we were particularly impressed with the interactive "human interface" qualities of the system. With the System Command Interpreter, the inexperienced user can be led through the over 170 procedures available via a menu-driven approach. The more experienced user can avoid the step-by-step hierarchy of menus and simply enter the necessary command directly.

Another feature of the DX10 system we enjoyed was the ability to design job stream or command files (TI calls them PROC's). Using the DX10 command language (SCI primitives), the user can create a file of commands that the SCI will execute. This gives the user tremendous flexibility and the opportunity to design "utilities" or procedures particular to the needs of the application. PROC's can be especially powerful due to the ability to perform loops and test counters within the PROC, thus enabling a given procedure to be repeated as often as requested (e.g., design a PROC to copy a file to a printer X times).

DX10 uses a mapping procedure to dynamically allocate memory to tasks as needed. The tasks are placed wherever space is available and may in fact be segmented into a maximum of three disjointed areas of physical memory. Though a task may be physically segmented, it appears contiguous to the programmer with a starting address of zero.

In addition to mapping, DX10 provides for priority setting and a roll-in/roll-out capability. If insufficient space is available for a program to be executed, the operating system seeks out suitable lower priority or suspended task segments and dispatches the programs to disk. Similarly when the task and priority mix indicates, the rolled-out program is rolled back in and execution resumed.

Another feature useful in multi-terminal environments is the ability to share procedures. Often in this type of environment, the procedural part of a program may be common to many users, whereas, the data for each user is unique. Under DX10, memory can be conserved by letting the users

share the procedural part of the application while keeping their own unique area for their data.

TI offers a number of packages including:

- TIFORM-990 - a generalized forms generator package that provides data input verification and allows screen layout and design to be handled independently from application program development; used in conjunction with programs written in FORTRAN, COBOL, and Pascal ($1,950).
- Sort/Merge - a sort/merge routine that can be accessed through SCI or CALLed from user programs ($2,500).
- DBMS-990 - a modular data-base management system ($2,300).
- Query-990 - an inquiry/report language which provides interactive access to data stored in the DBMS-990 data-base management system ($1,500).
- TIPE-990 - provides primary word-processing features in a menu/prompt format.
- TPL - a TI developed language for data entry/ data processing applications ($2,000).
- 3780/2780 Emulator - provides remote job entry communications to other computers employing IBM 3780/2780 protocol ($1,150).
- 3270 ICS - provides interactive remote communications to an IBM host ($1,450).

The users we surveyed could only be characterized as enthusiastic about the DX10 operating system. In general, they felt it was powerful yet easy to use. They had particular praise for the SCI menu-driven approach and for the TI text editor.

User Comments

- *The operating system was one of the reasons we chose the DS990.*
- *I like the menu-driven aspect of the system.*
- *I love the editor.*
- *There's a great interface between the computer and the operator.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- The DS990 supports the following languages (prices are the initial license price which includes the DS10 media, software documentation, and one-year of subscription/support service):

  - DX10 FORTRAN ($2,500)
  - DX10 990 BASIC ($2,450)
  - TI 990 Pascal ($1,950)
  - DX10 FORTRAN 78 ($3,000)
  - DX10 COBOL ($3,200)
  - RPG II ($2,200)
  - DX10 TPL ($2,000)

- TI does not offer application software. Application packages are available only through OEM's.

Our Observations

We found TI's DX10 COBOL to be a nicely enhanced version of COBOL that was easy to work with and performed well in our benchmark tests. This COBOL consists of a compiler and run-time interpreter. Source code is "partially or semi-compiled" and then executed in a run-time interpretive mode.

We also used TI's FORTRAN and Pascal in our benchmark application and found them both to be more than adequate. The Pascal version of our order-entry program provided the fastest response times, while the FORTRAN version was the slowest. The FORTRAN version displayed noticeable degradation as the number of terminals increased. This was due to the size of the program requiring roll-in/roll-out. Pascal and COBOL, on the other hand, used a common procedure for all eight terminals, thus eliminating any roll-in/roll-out.

Users were again highly pleased with this aspect of their DS990. They had almost nothing but praise for TI's languages, though they often wished TI would provide some application software.

User Comments

- *COBOL is easy to understand, logical, and has super flexibility.*
- *I'd like to see more application software.*
- *We're using COBOL and FORTRAN and they're both good.*
- *The DS990 has good development software.*
- *Pascal has a pretty long compile time . . . I wish they would speed it up.*

SUPPORT SERVICES

Summary of Features

- TI provides contract maintenance on all hardware sold. Basic coverage applies to locations within 100 miles of a TI service location and provides coverage Monday through Friday from 8:00 to 5:00. The monthly rate for contract maintenance on the system we tested would run about $340.

- TI also offers on-call maintenance for customers who prefer service on an as required basis.

- A subscription/support service is available for TI software. This service provides subscribers with the benefits of additional features or improvements to 990 software for a one-year period. Subscription/support for the DX10 COBOL used in our benchmark would be $1,250 per year.

- Regularly scheduled courses are offered by TI in programming and hardware maintenance. These courses are conducted at TI facilities in Chicago and Austin.

Our Observations

TI offers an enormous amount of documentation on the DS990 series of minicomputers. For the most part, we thought the documentation was quite good. The users we surveyed were split on this issue, though, with less than half feeling the documentation was good, while the rest felt that there was certainly room for improvement.

In the area of hardware service, users were uniformly pleased with the responsiveness of TI's service. Though few hardware problems were reported, when they did occur, service was quick and efficient.

User Comments

- *I think TI is a prime mover in the computer industry. They merit their good reputation.*

- *They need help on their documentation.*

- *The documentation is too technical.*

- *We get excellent service . . . after it was repaired, they called us back within the hour to check on it.*

- *Most maintenance contracts are tremendously over-priced, but we can get service on a per-call basis from TI.*

- *The documentation is good and understandable.*

- *The only bad feature on the Model 4 is its documentation.*

SUMMARY OF USER COMMENTS

With names provided by the Association of Computer Users, we contacted 15 users of the TI DS990 Model 4. Although its primary use was for standard business and accounting applications, the Model 4 was being used in a variety of engineering and production process applications as well.

User experience with the Model 4 ranged from under a year to over two years. Typical configurations consisted of the processor with 128k bytes of memory, at least 10 megabytes of hard disk storage, and from one to eight TI 911 terminals. About half the users had the 810 printer, while the rest used any one of a variety of other makes and models. One large manufacturing firm reported using 27 Model 4's with from two to eight terminals on each.

The consensus among the users on hardware reliability was, as one user said happily, "No problems." Overall it was rated very dependable and users were pleased with its design. When service was needed, the users were equally pleased with TI's quick and successful solution to their problem. "We get super support from TI and we think they do a very admirable job."

The majority of the users we contacted were using their DS990 in their company's accounting departments for accounts receivables, payables, and payroll. Other applications included inventory control, financial reporting, mathematics and engineering, production monitoring and control, and plotting.

Business applications were, in almost all cases, purchased as a "turnkey" package from an O.E.M. These users, who did little or no programming in-house, were, in general, quite satisfied with the package and the support they received from their O.E.M. The users we talked to with scientific and engineering applications were generally more "computer-sophisticated," doing nearly all their programming in-house. FORTRAN and Pascal were their languages of choice, while the business packages were programmed almost exclusively in COBOL.

The DX10 operating system was uniformly rated "excellent" and "easy to use" by new and more experienced users alike. They felt the DX10 was flexible and allowed for "smooth human interfacing." The editing capabilities of

the operating system were often singled out for praise by the users we surveyed. In general, users were quite happy with DX10's capabilities and design. As one user put it, "The operating system on the Model 4 far outweighs what is available on any other mini I've looked at."

The reactions of the users regarding documentation were somewhat mixed. Inexperienced users felt that the documentation was good, while more sophisticated users thought the documentation was only fair, or even poor. It seems their dissatisfaction stemmed mainly from those times they needed to use the documentation for reference, and not as a learning tool. As one user said, "It's all there, but it's hard to find."

The most frequently mentioned alternatives to the Model 4 were IBM, DEC, Datapoint, DG, and Burroughs. A common response was, "Oh, we looked at them all." The most frequently mentioned factors in choosing the TI were its modular design, flexibility, cost, and adaptability to their firms' growth. One large corporation was so impressed with their TI systems, that it is now their policy to use only TI equipment when a minicomputer is required.

Overall, the users we surveyed were overwhelmingly happy with the DS990 Model 4. Impressed with his Model 4, one user said, "I was surprised to find that a computer of its size could handle such a complex application as ours." Some of the first-time computer users were astonished by the increased efficiency of their processes now that they had the Model 4. As one euphoric department manager said, "What used to take us 6 weeks now takes us 6 hours." Another excited user answered questions about the DS990 at some length starting each reply with "super," "terrific," and "great." Then he summed up his feelings about his Model 4 with, "I guess you can tell I like the system."

CONCLUSIONS

The DS990 Model 4 micro-computer reviewed in this report, along with the DX10 operating system, proved to a versatile, easy-to-use computing system. This system is being used in a variety of business and non-business applications ranging from accounting and payroll, to production control and plotting. With a number of programming languages available, as well as interface hardware, the DS990 can be viewed as a general purpose computer capable of supporting a wide range of applications in any business.

The languages we tested in our benchmarks were COBOL, FORTRAN, and Pascal. Both COBOL and Pascal used shared procedures, where a single copy of the program was in memory, and each terminal using the program had its own data area. Thus, memory requirements are relatively low for multiple terminal applications. In FORTRAN, a separate copy of the program was required for each terminal. However, the operating system dynamically allocates memory (as opposed to the fixed memory partitions required on some systems), and can "swap" active and inactive programs between the system disk and memory. Thus, the effective memory size for multiple-terminal applications is larger than the physical memory size.

Since most of the languages are compiled or semi-compiled, the user must follow the standard edit/compile/link/load/execute sequence which can be time consuming during program development. However, this process is simplified with the very nice editing features and the menu driven operating system.

For the multi-terminal order-entry program, there was very little degradation in response as we moved from two to eight terminals with the COBOL and Pascal versions, but a doubling of response time with the FORTRAN version. There was a noticeable slowing of the CPU-intensive job as it was run in the background with more terminals.

Users were very happy with the hardware, software, and operating system on the DS990. They particularly like the menu-driven approach, and the editing capabilities. The only negative comments dealt with the documentation. While we found it useful and complete, we would agree that finding needed information could be difficult. However, the manuals were generally well organized.

In summary, the DS990 Model 4 is a reliable computer, versatile in the many languages and software available, and capable of performing very well in a variety of applications from business data processing to scientific and engineering computations.

BENCHMARK REPORT	An association to help the computer user make informed decisions. . .	ASSOCIATION OF COMPUTER USERS
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BENCHMARK REPORT/ ASSOCIATION OF COMPUTER USERS

VOLUME 3.2, NUMBER 5, OCTOBER 1980

In This Issue:

The HEWLETT-PACKARD 250

(Note: This is the multiple-user configuration; not to be confused with the ACU's Benchmark Report Vol. 3.0, No. 12 covering the single user configuration.)

HEWLETT PACKARD 250: BENCHMARK REPORT

TABLE OF CONTENTS

Preface

The fifth system to be evaluated in this series of reports covering multi-user systems in the $25,000 to $50,000 price range is the Hewlett-Packard 250. The comparative information provided by this series of reports will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source.

We have found that the technical specifications applied by manufacturers are difficult to interpret, and often misleading in terms of how systems behave in an application environment. Potential users need to know how well equipment performs in specific applications and how that performance compares among alternative systems.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order-entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Hewlett-Packard 250 used in our benchmark tests consisted of the processor with 256 kilobytes of central memory, a workstation with CRT and keyboard, a 1.2 megabyte floppy disk, a 12.1 megabyte hard disk, a 5-port Asynchronous Serial Interface, a 180 character per second printer, and the system software which includes HP's Business BASIC. Total price of the system as tested is $30,350 (four additional remote workstations would bring the price to $49,250).

- The HP 250 performed extremely well in our benchmark tests, recording the fastest times to date. Though the 250's upper limit of 5 additional terminals could prove to be a drawback, its performance in our tests certainly shows it to be a fine multi-terminal system.

- We were especially impressed with the "human engineering" of the 250. The design of the HP 250 workstation, with features such as an adjustable CRT on a swivel, keyboard at "typist" height, and "softkeys" on the bottom of the screen unit, combined with other features of the HP system show the special care HP has taken to provide comfortable human interaction with the 250.

- Our order-entry benchmark program was written in HP Business BASIC. We found this version of BASIC to be highly enhanced and very suitable for business application programming. Employing a "semi-compiled" design in an interactive environment, HP BASIC is easy to program, with full-screen editing capabilities and line-by-line syntax error checking. Excellent documentation fills out this "easy-to-program" impression of the HP 250.

- The HP 250 comes as a fully "bundled" system; that is, a full complement of software is included in the price. This software package includes all operating system routines, utilities, BASIC, HP's database management system (IMAGE/250), a forms generator and more.

- The users we contacted in our survey were nearly all first-time computer users. Despite this lack of experience, the users characterized the 250 as "friendly" and "user-oriented." Though most users expressed satisfaction with their 250, citing the general software design as its best feature, those who expressed dissatisfaction did so generally as a result of a poor working relationship with their O.E.M.

As we finished our benchmark testing of the HP 250, we were left with the feeling that "here's a machine we'd like to program." Its combination of hardware dependability and "user-orientation" make the HP 250 a good choice for experienced and inexperienced users alike.

BENCHMARK REPORT

SYSTEM: Hewlett-Packard 250

PRICE AS TESTED: $30,350

SPEED TESTS

CPU INTENSIVE

Benchmark Number		
A-4	N = 3000	24.7 seconds

I/O INTENSIVE

Benchmark Number		
B-4	N = 3000	10.0 seconds

"REAL LIFE" PROBLEMS

ORDER ENTRY

Benchmark Number		
D-1	2 terminals	2.1 seconds
D-2	4 terminals	2.2 seconds
D-3	6 terminals	*
D-4	8 terminals	*

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	2 terminals . .	48.2 seconds	2.2 seconds
E-2	4 terminals . .	47.6 seconds	2.3 seconds
E-3	6 terminals . .	*	*
E-4	8 terminals . .	*	*

*Five is the maximum number of remote terminals that can be run on the HP 250.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Hewlett-Packard and requested their assistance in benchmarking a multi-user version of their HP 250 computer. We requested that the total system be priced in the $25,000-$50,000 price range, and that this price include as many terminals as possible up to a maximum of eight.

HP provided us with a 250 at their facility in Cupertino, California. The system consisted of a processor with 256K bytes of central memory (96K for the user), the workstation with CRT and keyboard, a 1.2 megabyte floppy disk, a 12.1 megabyte hard disk, a 5-port Asynchronous Serial Interface, a 180 character per second printer, and the system software which includes HP Business BASIC. This system was priced at $30,350. HP also provided us with programming and other on-site technical support for our benchmark.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the HP 250) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and 2 reports).

Benchmarking the HP 250

One day was all that was required to benchmark the HP 250. Upon arrival, our equipment was set up and communications were easily established between the RTE and the 250. With the assistance of HP personnel, a couple of minor problems with the order-entry program were corrected, and within an hour, the benchmark testing began. No further problems were encountered and the benchmark testing was easily completed.

Our Observations

As our readers have no doubt noticed by now, we are of the belief that one of the most important aspects of a computer system is its "human engineering" or interfacing. It is in this area that the HP 250 definitely excels. From the physical design of the workstation to the ease of programming in the interactive BASIC environment, the HP makes the user feel "comfortable."

The workstation consists of a desk with cabinets for the processor and other circuit boards, space for the diskette and the 12.1 megabyte hard disk drive, a built-in keyboard which is located at an easy-to-reach height, and a swivel-attached movable CRT. This package provides an attractive and comfortable area for data-entry or programming.

Similar to other machines we've tested at the Business Research Division, the 250 is what might be called a "totally interactive" system. That is, there is no operating system/programming environment dichotomy present, like that found on many other machines. All interaction with the 250 is done via an application or utility program, or in the BASIC programming environment. As a consequence, users need not learn both an operating system language (a JCL) and a programming language, but need to know the names of utility programs to RUN, or the BASIC statements needed to accomplish the task.

In our short time with the HP 250, we quickly grew to enjoy the ease with which the computer can be programmed. As we've emphasized before, we feel that a menu-driven approach is the best way we've seen to provide for easy human/computer communications. We found that programming menu-driven applications on the HP 250 would be an easy, almost enjoyable, task. Through the use of "softkeys" (eight programmable function keys located on the bottom of the CRT screen), the programmer can design a menu-driven application to make even the most inexperienced computer user feel comfortable.

HP's Business BASIC is a highly enhanced version of BASIC that we found to be extremely powerful and easy to use. Employing what might be called a semi-compiled design (see LANGUAGES Detail page), each line is checked for syntax errors as it is entered. Editing is easy with full-screen cursor control and scrolling capabilities.

System generation is accomplished with a program called CONFIG. Using an interactive menu-driven approach, this program allows the user to review and change the system software configuration, memory assignments, I/O configurations, and autostart. When this process is completed, the new system can then be booted. During the "boot-up" process, the 250 does a hardware self-test and reports any hardware malfunction. If the operating system configuration is incorrect, the system will automatically provide a configuration adequate to operate the system console, so that the user may re-run CONFIG and correct the error. During our benchmark tests, we found this sysgen process to be easy and quick.

One feature we particularly liked on the HP 250 is the excellent documentation. In fact, we're not sure we've seen better documentation anywhere! Information is nicely organized and well indexed with numerous examples provided.

The structure of the order-entry program written for us by HP personnel was unique in our series of benchmark tests. Instead of using multiple copies of the order-entry program (one for each terminal) or using re-entrant code which is shared by each terminal (with separate partitions or data areas for each), this program took advantage of some of the unique characteristics of the 250. This version consisted of one program which treated each terminal as simply an I/O device and, in effect, "polled" each terminal to see if it had input information. If so, this information was processed, and then the polling function resumed. This approach is made possible by a buffered terminal I/O interface which generates interrupts when a whole line has been received from a terminal, thus freeing the CPU from character-by-character processing. Using statements in HP BASIC designed for this purpose, input can be easily recognized, processed, and polling then resumed. It is this program structure that is responsible, in part, for the fast times we observed in the order-entry benchmark.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	24.7 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average

run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	10.0 seconds

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order Entry Run in Production Mode

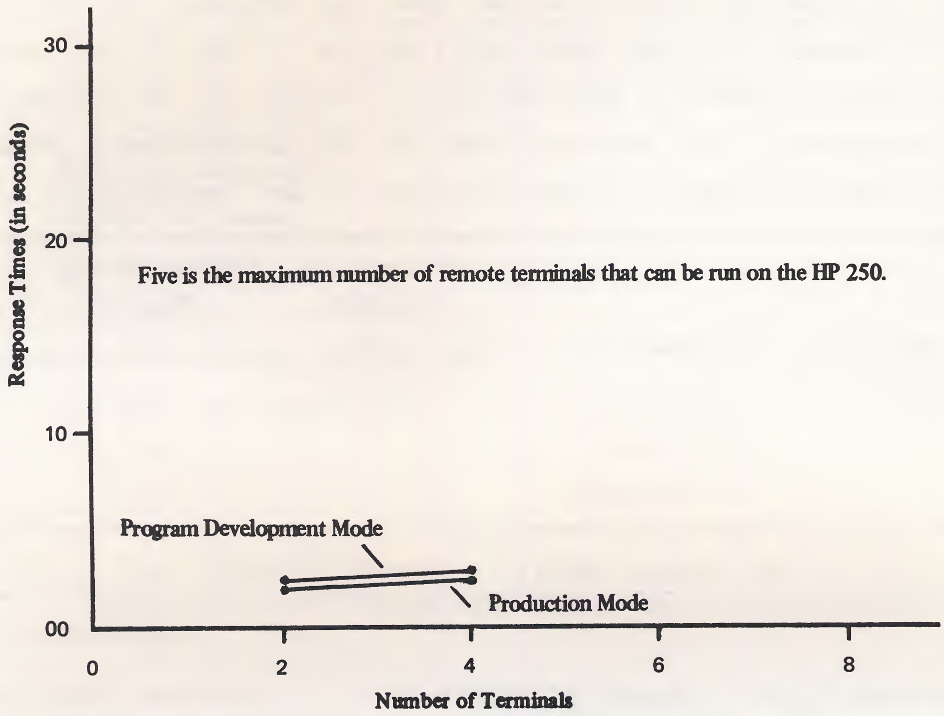
The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	2.1 seconds
D-2		4 terminals	2.2 seconds
D-3		6 terminals	*
D-4		8 terminals	*

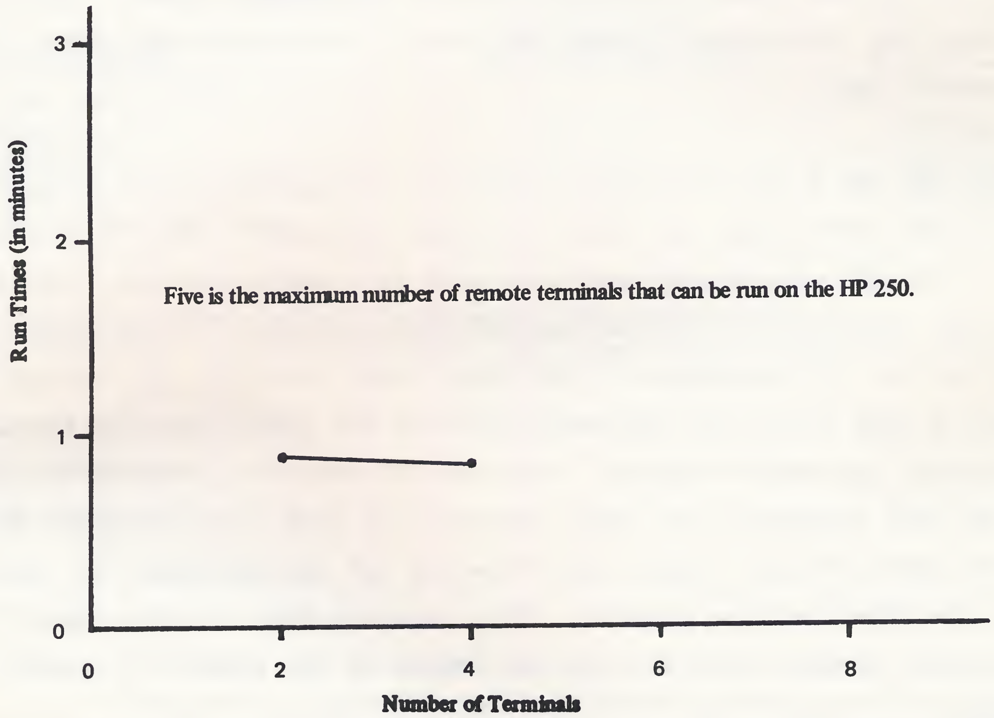
*Comment: *Five is the maximum number of remote terminals that can be run on the HP 250. A 5-terminal test yielded a time of 2.2 seconds.*

BENCHMARK TIMINGS: HP 250

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	48.2	2.2
E-2		4 terminals	47.6	2.3
E-3		6 terminals	*	*
E-4		8 terminals	*	*

*Comment: *Five is the maximum number of remote terminals that can be run on the HP 250. A 5-terminal test yielded 47.5/2.4 times.*

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real-life" problem. The first shows the time for the order-entry program for 2, 4 and 5 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times for the CPU-intensive job.

The times for the 6 and 8 terminal runs (D-3, D-4 and E-3, E-4) are not reported due to the HP 250's limit of five additional terminals. The times which are reported indicate the HP performs very well in a multi-terminal environment. The curious result of the CPU-intensive times decreasing as terminals are added is explained by the structure of the order-entry program. It employed a program with a loop which was constantly polling for input from the terminals. This polling loop would "compete" with the CPU-intensive program for the CPU's time. As more terminals are added, the polling loop is interrupted for terminal and disk I/O more often, thus "freeing up" the processor to spend more time on the CPU-intensive program. This resulted then, in the times for the CPU-intensive program actually getting faster as the number of terminals increased.

SYSTEM AS TESTED: HP 250

Costs

HP 250 System	$17,000

- Processor with 160K bytes of memory (128k system, 32K user)
- Workstation with display screen and keyboard
- 1.2 megabyte floppy disk drive
- Printer interface
- System software
- Documentation

Replace 32K user memory with 128K	$ 1,600
12.1 megabyte hard disk	$ 6,000
5-port Asynchronous Serial Interface	$ 2,100
180 character-per-second printer	$ 3,650
Total System	$30,350

Our Observations

Additional terminals could be either of two non-intelligent terminals, the 2621A or the 2645A ($1,495 and $3,500 respectively), or a workstation terminal, the REMOTE/250 ($4,250). The REMOTE/250 may be used for data-entry and programming, while the two non-intelligent terminals can only be used for data-entry. Each additional REMOTE/250 requires 32K of additional memory as well.

Configuration	Total Price with REMOTE/250's	Total Price with 2621A's
Single user system (console only)	$26,650	$26,650
System with two terminals	$34,900	$31,845
System with four terminals	$44,000	$34,835
System with six terminals	$54,400	$37,825

The multi-terminal prices given above include the ASI board, terminals, and additional memory if needed. Included in the number of terminals is the console.

Summary of Equipment and Features

- The HP 250 processor is a 16-bit processor with 12 significant digit floating point precision. The processor is housed in the HP 250 desk in a 16 slot motherboard.

- The operating system, which is memory resident, requires a minimum of 128K bytes of central memory. A single user configuration adds 32K or 64K for user memory (5K of user memory is required for console overhead--display screen, memory buffers, etc.). Multiple user configurations require at least 160K for the operating system (or 192K if desired), and an additional 32K for each REMOTE terminal (and the console). Each user memory area can be increased to a maximum of 64K. Nonintelligent data-entry terminals do not require additional memory (other than that required by the program which monitors them). Add-on memory boards come in 32K, 64K, and 128K increments at prices of $1,250, $1,900, and $2,500 respectively.

Our Observations

To extend the addressing capabilities of the processor, and thus allow a multitask system, the HP 250 employs block switching to select desired memory blocks. Sixteen memory blocks of 64K bytes each can be addressed. However, in actual operation the total addressing capability is not used due to the limited number of memory board slots and power supply limitations. Block switching permits the 250 to support up to 5 additional consoles (REMOTE/250's) in a time-shared manner. Each memory block is provided a CPU "time-slice" so that it may use the processor, system disk or printer.

In our benchmark tests, we were impressed with the HP processor and central unit configuration. Its timings in our order-entry test were extremely fast, and showed little degradation as terminals were added. Given this good performance, though, we were disappointed that only five additional terminals could be added to the 250. We felt that this limitation might inhibit some potential users who plan on expanding their system to over six total consoles (yet want to start out at a "small-system" price).

The users we talked to praised the hardware reliability of the HP 250 with most commenting that they had few if any problems with their system. A couple of users did report, contrary to our benchmark results, that their system experienced significant response degradation as terminals were added to the system. We were unable, however, to ascertain whether this problem was a function of HP hardware/software or the user's own application program.

User Comments

- *Never been down for a hardware problem since we've had it.*
- *It's slow when all our terminals are up and working.*
- *We never turn if off . . . it even prints reports on the weekend.*

STORAGE DEVICES

Summary of Equipment and Features

- The standard HP 250 package comes with one floppy disk drive located below the drawer on the workstation. This drive employs double-sided media recorded in double-density format to yield a 1.2 megabyte capacity.
- A 12.1 megabyte hard disk is available (and used in our benchmark tests). This drive features Winchester-technology and medium, and resides in the main system console just below the floppy disk drive.
- The HP 7906 drive is also available. This 19.6 megabyte drive is located in a stand-alone "lowboy" cabinet and features a 9.8 megabyte fixed disk and a 9.8 megabyte front-loading removable cartridge disk. Priced at $13,000, up to two 7906 drives may reside on a system.
- Total secondary storage for the HP 250 adds up to 33 megabytes and consists of one floppy, one Winchester, and two 7906 drives. Tape storage is not available for the 250, although the 2645A non-intelligent terminals feature cassette tape storage for off-line data-entry.

Our Observations

Our tests using the 12.1 megabyte hard disk revealed it to be quite suitable for business applications. This small, "drawer-sized" disk performed very well in our tests. In fact, some additional timings we ran indicated that, in our order-entry application, the 12.1 megabyte disk was only about 5% slower than the larger 19.6 megabyte disk.

One feature we found to be useful in a multi-terminal environment is the DOOR LOCK/UNLOCK statements available in HP BASIC. These statements allow a user to lock the diskette door in order to avoid accidental removal of an active diskette. Other BASIC statements help to provide file security in a multi-user situation by assigning file passwords and controlling multi-user file access.

The users we contacted in our survey were generally happy with the storage capacity of their system. There were a few negative comments about the storage access speeds, primarily regarding the floppy disk drives.

User Comments

- *Data storage is more than adequate.*
- *The weak link is the diskette drive.*

Summary of Equipment and Features

- The system console on the HP 250 is a desk which contains the CRT, keyboard, processor, and disk drives. The CRT is an adjustable display screen on a swivel with an 80 x 24 character display. The display memory allows scrolling through the use of the up and down cursor keys. Other screen features include half-bright, underline, blinking or reverse video, and a blinking cursor. On the bottom of the screen are 8 "softkeys," which are programmable function keys. The console keyboard features a typewriter block, a separate numeric pad, and 16 more function keys.

- Terminals for the HP 250 include the REMOTE/250 intelligent terminal and the 2645 and 2621 non-intelligent terminals. The REMOTE/250 (priced at $4,250) is a full workstation with all the functions of the system console (except for softkeys on the bottom of the screen). Programming and remote data-entry can be done from a REMOTE/250, while the non-intelligent 2621 and 2645 ($1,495 and $3,500) allow only data-entry under program control. The 2645 also includes a cassette tape storage unit which allows off-line data-entry.

- The Asynchronous Serial Interface ($2,100) provides a 5-port intelligent interface for REMOTE/250 consoles or standard RS232C terminals and printers. The ASI, when combined with the LK3000 utility, also offers asynchronous serial communications with the larger HP 3000.

- An Intelligent Network Processor (INP/250) provides communications with IBM-compatible mainframes using IBM bisync protocol. RJE/250 is the program that tailors the INP/250 board for remote job entry. Cost of the emulator is $3,225.

- Printers for the 250 include a 180 character-per-second serial printer, a 400 line-per-minute line printer, and a 30 cps character impact printer ($3,650, $10,175, and $3,600 respectively).

Our Observations

HP's design of their console and terminals shows their concern with providing a comfortable human/computer interface. Things like locating the keyboard at a "typist" height, a movable CRT on a swivel, and easy access to the floppy disk drive help to make the HP 250 a more "easy-to-run," more "fail-proof" machine.

Users generally raved about the HP terminals, especially the softkeys. When used in menu-dirven applications, their location at the bottom of the CRT helps to minimize errors by having the operator "point" to a choice when pressing the key.

User Comments

- *The softkeys are great!*
- *The softkeys are nice on the main console, but on the REMOTE/250's they're on the keyboard and not so easy to line up with the screen.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- HP 250 system software consists of the BASIC interpreter and extensions to the language called "DROMs." A DROM (Dynamic ROM) is a group of assembly language routines that enhance the capability of BASIC. DROMS typically contain:

  - the database management system
  - mass storage device drivers
  - printer and other peripheral drivers
  - additional BASIC statements and functions
  - other miscellaneous control functions

- All HP system software is included in the price of the system.

Our Observations

The HP 250 could be called a BASIC language machine. All statements in BASIC and system commands are executed on the same level, either in a program or directly from the keyboard. This structure eliminates the more typically found job control language/programming language dichotomy, but as a consequence the user must be familiar with all the commands and functions available. There is no menu-driven approach to the operating system, unless the user (or O.E.M.) programs one. Fortunately, programming menu-driven applications on the 250 is easy and efficient with the use of the softkeys and other BASIC enhancements.

One feature of the operating system we particularly liked was the system self-test. Upon power-up, the system initiates a test of the processor, block switch, I/O channel and memory. The results are then displayed on the CRT. In addition, if the user system configuration does not match the available hardware, error messages will be displayed. In fact, if the system as configured by the user is totally incorrect, the 250 will always bring up a minimum configuration for the system console so that corrections may be made.

The system software includes:

- HP Business BASIC - (see next section for a description)

- IMAGE/250 - a database management system. A true DBMS, IMAGE allows logically related data to be placed in an integrated database which can then access data according to its defined structure without regard to its physical placement. Components of IMAGE/250 include schema processor utilities, access procedures, database utilities, and QUERY/250, a database query facility.

- SORT/250 – a sorting package which can sort simple data sets and sort across multiple data sets.
- QUERY/250 – an inquiry facility for IMAGE/250 databases. This facility allows ad hoc inquiries with no programming required and also features a forms-driven command input for the novice user.
- PACK/250 – used in transferring string and numeric data to and from a strong variable.
- FORMS/250 – allows creation and use of forms for data entry and display.
- REPORT WRITER/250 – a set of BASIC commands which aid in writing programs to produce reports.
- Additional utilities – includes CONFIG (allows user to configure system), ROUTIL (copy routines), XREF (cross reference program), TEST (series of hardware tests), and INIT (disk initialization routine). All of these utilities are written in BASIC.

Optional DROMs which may be configured in the system allow for communication with REMOTE/250s (RIO) or remote RS232C devices (TIO), HP3000 communications and a SPOOLer.

The users we surveyed were very satisfied with this aspect of the HP 250. Almost unanimously they applauded the "friendliness" of the system and had special praise for the DBMS.

User Comments

- *Its best feature is its friendliness . . . it's just a very friendly system to work with.*
- *We got the 250 for two reasons: HP's reputation and QUERY.*
- *It's easy to make the 250 friendly for users.*
- *The reason we got the HP 250 is simple . . . the database and QUERY.*
- *We felt they had the software that fit our needs: IMAGE/250.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- HP Business BASIC is the only language offered on the 250. A highly enhanced version of BASIC, some of its features include:

  - full-screen editing of program text and line-by-line syntax error checking; debug, trace and "step-through" for program debugging

  - structured programming statements, "softkeys," COMMON storage, a matrix package

- The following packages are offered by HP to O.E.M.s for modification and distribution. HP is not staffed to support individual users of these packages.

- FIN/250	includes payables, receivables, and general ledger ($7,500)
- OM/250	includes order-entry, finished goods inventory control, receivables, and sales analysis ($10,000)
- MFG/250	includes bill of materials, product costing, and raw materials inventory control ($7,500)

Our Observations

HP 250 BASIC is an interpretive language, so a program can be listed at any time in its original form. However, this version of BASIC is different from most in that it does a line-by-line syntax check and what might be termed a "semi-compilation." Most versions of BASIC store the program in its character form and subsequently check syntax each time a statement is executed. HP BASIC stores the program as pointers to the proper execution micro-code for each operation, as pointers to a symbol table for variables and constants, or as pointers to a scratchpad location for temporary result storage. This type of internal form (sometimes called pseudocode) helps increase execution speed by operating on pointers rather than character form.

Users we contacted were very happy with HP BASIC, often comparing it to other high-level languages such as FORTAN, COBOL, or Pascal. Feelings on application programs were much more mixed, with a number of very dissatisfied users (see Support Services section for comments).

User Comments

- *HP BASIC is extremely flexible.*
- *HP BASIC is superior, very close to Pascal when it's full blown.*
- *After using HP BASIC, I'll never use FORTRAN again.*
- *HP BASIC is the best I've seen.*

SUPPORT SERVICES

Summary of Features

- Hewlett-Packard offers three different maintenance contracts for hardware service. These run from a basic agreement (8 to 5, Monday through Friday) to extended coverage (24 hours a day, 7 days a week).

- HP Customer Support Service ($150 per month) offers the user all updates/improvements to the system, phone and on-site consultations.

- HP also offers training and consultation including:

  - a consulting service, eight hours at the customer site ($500 per day)

  - five days for one student at a HP training center ($625)

  - on-site comprehensive introduction for ten students for five days ($6,000)

Our Observations

HP documentation on the 250 is, in a word, outstanding. We found it to be very easy to read, informative, well-indexed, and chock full of examples.

The HP users we talked with agreed the documentation is great. They were also uniformly pleased with the hardware service they had received. Unfortunately, this was not always the case with the application software. As the following user comments show, overall satisfaction definitely depended on the service/support they received from their O.E.M.

User Comments

- *The documentation is easy to follow and well laid out with examples.*
- *The documentation is the best . . . superb!*
- *Excellent service, they were here within two hours after we called.*
- *Service from our software house has been fantastic.*
- *Terrible service from our OEM . . . they didn't follow through.*
- *Service from our software house is very poor.*
- *Very quick service, the service reps knew what they were doing.*
- *Service from our O.E.M. has been extremely good.*
- *The machine itself is good, but it's difficult to look at it objectively since the software service from our O.E.M. has been so poor.*

SUMMARY OF USER COMMENTS

Using names supplied by Hewlett-Packard, we contacted 15 firms which were using the HP-250 in a multi-user capacity. These firms consisted of manufacturers, medical billing firms, and a consulting engineering firm. In all cases, the 250 was being used for standard business applications including payables, receivables, and inventory. A few firms also used their HP 250 for mathematical and engineering applications as well.

The standard hardware configuration for the HP 250 consists of the processor with 160K memory, a 1.2 megabytes floppy, and the console terminal with softkeys. In addition to this standard configuration, most users had the 19.6 megabyte fixed/removable disk, the 180 cps printer, and from one to three REMOTE/250 terminals. Generally the users liked the printer and the terminals; however, some commented that the placement of the softkeys on the keyboard (on the REMOTE/250s) made visual alignment with the screen a little awkward. The users were also generally pleased with the amount of central memory and hard disk storage.

Nearly all of the firms we contacted had purchased the HP 250 as their "first" computer system. Users' experience with their 250 ranged from 2 years to less than a year. At least five different individuals in each firm were using the 250, most of whom were quite new to computer systems. Despite user inexperience, however, the 250 was getting heavy usage, which supports such comments as the "friendliness" of the computer and "it's very user oriented."

The users we talked to had evaluated many of the better known computers including Wang, NCR, DEC, IBM, Burroughs, Univac, Honeywell, TI and Data General before buying the 250. The reason most often given for choosing the HP 250 was "the software." Some users were more specific and gave "Query" as their reason. A common remark was, "The reason we got the HP 250 is simple: The data base and Query." The owner of a billing firm said, "We went into business based on what we knew the 250 could do."

All of the users were extremely pleased with hardware reliability, and any problems encountered were considered "minor." The users were also very happy with the "excellent" service they got from Hewlett Packard.

The users were equally pleased with the software packages and the HP BASIC language. One user, probably more realistic about what to expect from computers than others, said, "We expected a lot of bugs in the packages but there just weren't any." And a comment about the BASIC was, "HP BASIC is superior, very close to Pascal when it's full blown."

Users were divided, however, on the quality of software support they received from O.E.M.s. Two users made comments completely opposite to each other: one said, "Service from our software house has been fantastic," while the other remarked, "Terrible service from our software house--they didn't follow through." All felt that HP's documentation is "very exceptional," and "superb."

Users' perceptions of the operating system and its overall efficiency were positive, but some felt it slowed down or became essentially a single-user system when the volume of data or complexity of the programs increased. When questioned about the cause of this degradation, most users found it impossible to determine whether the system software or their own application was at fault. One user commented, "When running some of our programs other terminals can't access the main disk until the program is finished, which then creates a backlog." Another user said, "Speed is good with one terminal but with two it slows down noticeably." There were other users, however, who felt the system was "relatively quick," which was more in line with our findings in the Benchmark process.

The general design of the software packages, the language, and the unique features of the hardware such as the softkeys seemed to contribute to users' overall satisfaction with the system and with what they called its "great human engineering." Their overall assessment of the HP 250 has to be viewed from two perspectives, though. Those users who had a good working relationship with their O.E.M. were quite pleased, while those who were struggling with the O.E.M. for support expressed a less positive viewpoint. But somewhere in between there were a lot of happy users of the HP 250. Several comments were, "By golly, it's got so much on it," and "Almost everything you want to do you can do."

CONCLUSIONS

The Hewlett Packard 250 reviewed in this report, originally designed as a single user system, proved to be an excellent performer up to its five remote terminal limit. Based on an operating system which is fully integrated with an enhanced BASIC language, we found the HP 250 to be an easy machine to program and operate.

The main workstation, with its computer, keyboard, CRT, and disk drives, was designed with the operator in mind. The swival CRT has programmable "softkeys" which allow single keystrokes as a response to the programmed prompt. Workstation design, along with ease of operation and programming indicate the extent to which HP is concerned with the human interface.

The enchanced BASIC is interactive, with full screen editing, syntax checking as each line is entered, and structured programming statements. Additionally, it is very easy to write "menu driven" applications, and is well designed for business programming. Documentation on the system is excellent.

The HP 250 produced the fastest times to date on our order-entry benchmark program. This was mainly due to the unique way in which the program was designed and implemented by Hewlett Packard personnel, taking full advantage of the BASIC language statements as well as the buffered input/output capabilities of the hardware.

Users were generally enthusiastic about the HP 250, especially the BASIC language and software such as the data management system. As usual, dissatisfaction with the system occurred when the user was unhappy with the O.E.M. who supplied the system and applications packages. The system was generally classified as very "friendly" and "user oriented."

The major limiting factor for a growing business might be the five remote terminal (plus console) maximum configuration. If expansion is a factor, HP would probably recommend the low end of the 3000 series as a starter system rather than the HP 250.

While the HP 250 is relatively expensive, its integrated system, along with the human engineering, make it a very usable computer capable of supporting the computing needs of many small and medium sized businesses.

BENCHMARK REPORT	An association to help the computer user make informed decisions. . .	ASSOCIATION OF COMPUTER USERS
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BENCHMARK REPORT

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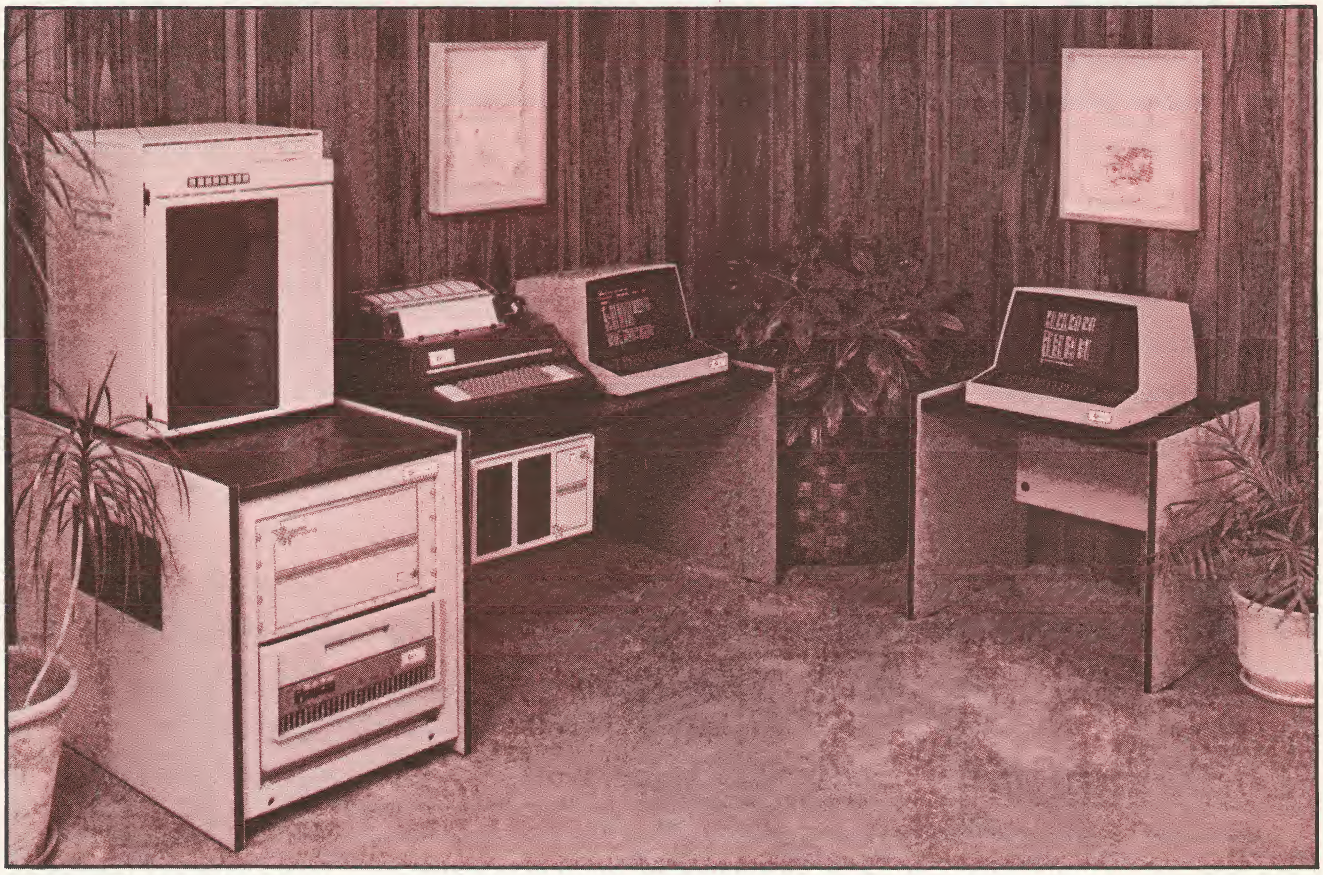

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The ALPHA MICRO AM-100T

ALPHA MICRO AM-100T: BENCHMARK REPORT

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PREFACE

Our sixth report in this series of Benchmark Reports on multi-user systems in the $25,000 to $50,000 price range covers the Alpha Micro AM-100T. The comparative information provided by these reports will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source. The report which follows this report will be a six-month summary of the six systems we've tested to date.

We have found that the technical specifications supplied by manufacturers are difficult to interpret, and often misleading in terms of how systems behave in an application environment. Potential users need to know how well equipment performs in specific applications and how that performance compares among alternative systems.

The measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard work load," a benchmark, and measure how well various systems perform this standardized task. We have developed a set of three benchmark programs to be run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single user systems under $25,000 covered in those reports. The third program is a multi-terminal order entry system specifically designed to measure degradation in response time as terminals are added to the system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Alpha Micro AM-1051 computer system is packaged with the AM-100T processor, 64 kilobytes of error-correcting memory, a 90 megabyte fixed/removable disk drive, the AMOS operating system, three high-level languages (BASIC, PASCAL, and LISP), and utilities. With the addition of three more 64 kilobyte memory boards (for a total memory size of 256 kilobytes), two AM-300 6-port serial I/O boards (to allow for a console terminal and eight remotes), a Lear-Siegler ADM-3A+ terminal, and a TI 820 printer, total system price is $35,680.

- The system configuration and prices given above are for a "standard" configuration that would be suitable for our benchmark order entry system. The system actually used in our benchmark (at a private user site), had a configuration which was essentially similar except for containing more central memory and dual Trident drives. Because the system we tested was a private user's own configuration and not one packaged by the manufacturer for our benchmark application, we are reporting the manufacturers price and configuration that is appropriate for this application and comparable to other systems we've tested in our reports.

- Alpha Micro now features Control Data Corporation's Hawk and Phoenix drives, rather than the Century Data Trident drives we tested. The Trident line of drives are still available with the Alpha Micro from certain dealers, and Alpha Micro still supports the use of these drives on their systems.

- Alpha Micro offers two different processors with their computer systems; the AM-100 and the AM-100T. The AM-100T processor which we used in our tests is a capable 16-bit processor, which, Alpha Micro reports, should produce speeds up to 80% faster than systems which use the AM-100.

- System software, programming languages, and utilities are included in the Alpha Micro package price. We found AMOS (the Alpha Micro operating system) to be a powerful, flexible system with utilities and features that combine to make it a highly adaptable, easy-to-program machine.

- AlphaBASIC, used in our benchmark programs, is an enhanced version of BASIC that contains many features which make the language efficient both in terms of programming ease and execution speed. Though AlphaBASIC is a compiled language, it also offers an interactive mode for program development and debugging.

- The users we spoke to in our survey reported few hardware problems and generally cited the system software as the Alpha Micro's strong point. Most were doing some or all of their programming in-house and often commented that though they encountered "bugs," they found the AM software constantly improving as new versions were released.

The users we spoke to in our survey concur with our observation that the Alpha Micro system is a reliable piece of hardware whose strong suit is powerful, well-designed system software.

BENCHMARK REPORT

SYSTEM: Alpha Micro AM-100T

PRICE AS TESTED: $35,680*

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-4	N = 3000	31.4 seconds
	I/O INTENSIVE	
B-4	N = 3000	42.9 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	3.1 seconds
D-2	4 terminals	3.2 seconds
D-3	6 terminals	3.8 seconds
D-4	8 terminals	4.0 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	**2 terminals . .**	33.4 seconds	3.8 seconds
E-2	**4 terminals . .**	37.0 seconds	4.0 seconds
E-3	**6 terminals . .**	42.6 seconds	5.1 seconds
E-4	**8 terminals . .**	45.2 seconds	5.7 seconds

Note: Order Entry Program times represent average processing time per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

* This price is for an "equivalently" configured Alpha Micro package, the AM-1051. Actual configuration tested (see Executive Summary) was the configuration we found in use at a private user's facility.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Alpha Micro and requested their assistance in benchmarking the AM-1051. Alpha Micro indicated that they did not wish to participate in the benchmark testing in any direct or indirect capacity. Therefore, we hired an independent programmer, experienced with the Alpha Micro system, to write the order entry code. It is probably correct to assume that if Alpha Micro had written the code themselves, they may have optimized the code to a greater extent than the version we ran.

ACU located an Alpha Micro system at a private user's facility. Unfortunately, we were not able to locate an AM-1051 "package" per se, but rather, located a system which used the same AM-100T processor. This system differed from the AM-1051 in the hard disk configuration (Trident drives versus the CDC Hawk or Phoenix) only. The system we tested then was configured with the AM-100T processor, 384 kilobytes of central memory, dual Trident drives, two AM-300 6-port serial I/O boards, a terminal, and a TI 820 printer.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the Alpha Micro) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-intensive and CPU-intensive program timings were made using a stopwatch (as in our Series 1 and Series 2 reports).

Benchmarking the Alpha Micro

Two visits over two days were required to benchmark the Alpha Micro. Establishing communications between our RTE and the Alpha Micro was an easy process. We did, however, encounter some program "bugs" in the order-entry program. With the knowledgeable assistance of our user/host, we corrected the program and successfully completed the benchmark testing.

Our Observations

To familiarize ourselves with a system prior to benchmarking it, we obtain documentation on the system and study it to become acquainted with the operating system, languages, etc. It is in this area that our first favorable impressions of the Alpha Micro began. We found Alpha Micro system documentation to be nothing less than outstanding. From reference manuals to "how-to" manuals, AM documentation was consistently concise, useful, and well organized. AM's "Introduction to AMOS" manual deserves special praise for its clear explanation of the Alpha Micro system specifically, and computers/operating systems in general. Written with the less-experienced user in mind, the Introduction helps to introduce the novice user to computers and "computerese."

As the users in our survey commented, and we found in our own experiences with the Alpha Micro, AM system software is the highlight of the machine. Though not employing a menu-driven approach, AMOS (Alpha Micro Operating System) is easy to work with and powerful. Though we feel a menu-driven approach is better from a human/computer interfacing perspective, interaction with AMOS is straightforward, and a HELP command is available to provide information to the user on various AMOS commands. Once a user has become acquainted and comfortable with the system, command and DO files can be created to perform tasks frequently invoked by the user. (Command files are files of AMOS commands that are executed upon typing in the name of the command file. DO files are similar except for the use of special symbols in the file so that arguments may be passed to the command file when called.)

System generation (or configuring the operating system software for a particular hardware configuration) consists of creating a command file (SYSTEM.INI) which is read by the operating system during the "boot-up" process. This file informs the operating system about the particular hardware/software

configuration to be employed by the user. Creation of SYSTEM.INI does require a fairly good understanding of the Alpha Micro equipment and procedures, but the file does come with the system when purchased, and the documentation describing the procedure is, for the more experienced user, quite helpful and informative. A feature we especially liked was the MONTST command which allows the user to "bring-up" and test a system command file (using a file name other than SYSTEM.INI) without "risking" modifications to the existing system. We also appreciated the fact that the whole sysgen procedure is quick, generally taking less than a minute.

Our order entry benchmark program was written in AlphaBASIC. We found this language to be an efficient and powerful compiled version of BASIC. Features such as MAP statements (which allow COBOL-like data definition), unlimited-length variable names, and fully supported floating point hardware make AlphaBASIC highly suitable as a business programming language. Though it is a compiled BASIC, AM provides an interactive mode which, though still compiling the source code, simulates an interpretive environment.

As we created and modified programs on the Alpha Micro, we appreciated the interactive mode for program debugging purposes, though we wished a better editor was available in this mode (a line must be retyped to make a correction). Most programmers who are experienced with the Alpha Micro, we were told, use AM's full-screen editor (VUE) for program creation, and use the interactive mode solely for program debugging. As we became familiar with VUE, we became more and more impressed with this powerful editor and consider it one of the nicer features of the Alpha Micro system. Perhaps the biggest advantage of VUE (over other full-screen editors we've seen) is that it does not require an expensive intelligent terminal, but rather can employ a far less expensive "dumb" terminal, yet still offer full-screen editing capability.

Using version 4.4B of the AMOS operating system (the most up-to-date released version at that time), our memory configuration for the order-entry test consisted of one 32 kilobyte bank for the operating system, terminal drives, and ISAM routines, another 32K bank for other system use (bitmaps, spooler, etc.), and one 32K bank for each of nine terminals. We used this much memory only because it was conveniently available on the system we tested, though this same order entry application could have easily been contained in 256 kilobytes (or perhaps less) through greater use of Alpha Micro's shared memory (see Detail pages).

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying numbers of terminals
- An Order Entry program run with varying numbers of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	31.4 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	42.9 seconds

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order Entry Run in Production Mode

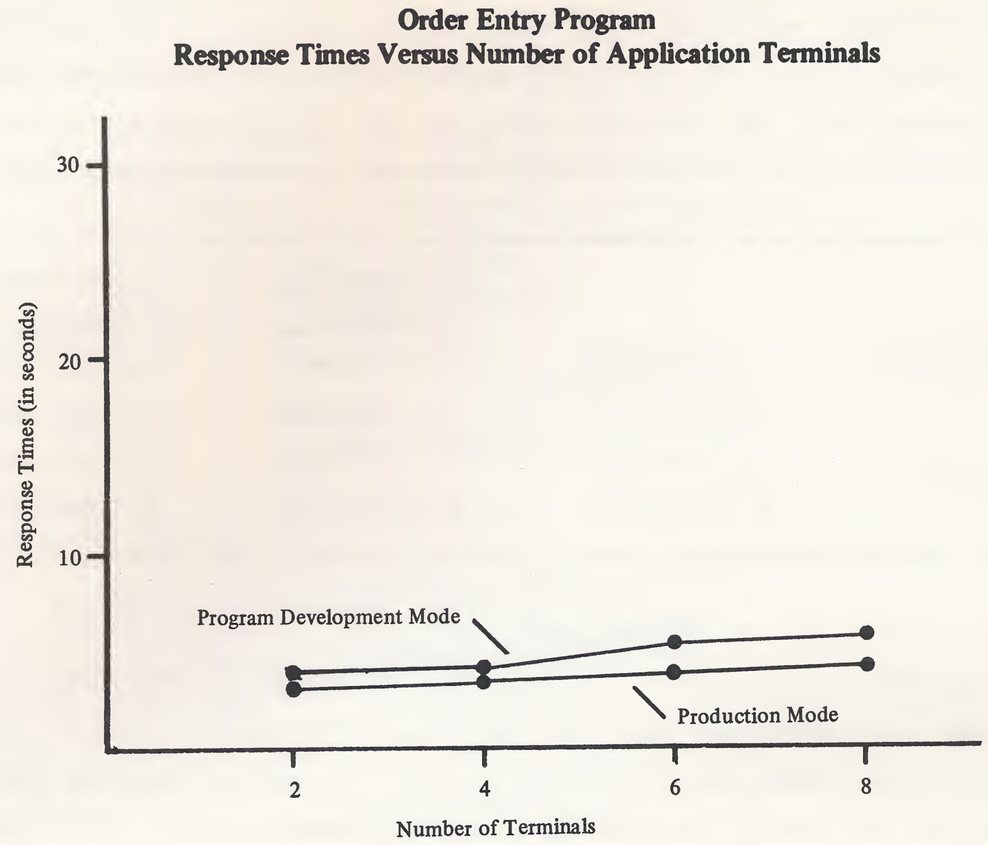
The order entry program was run with 2, 4, 6 and 8 terminals and no other programs running on the system. This would be a typical production mode application.

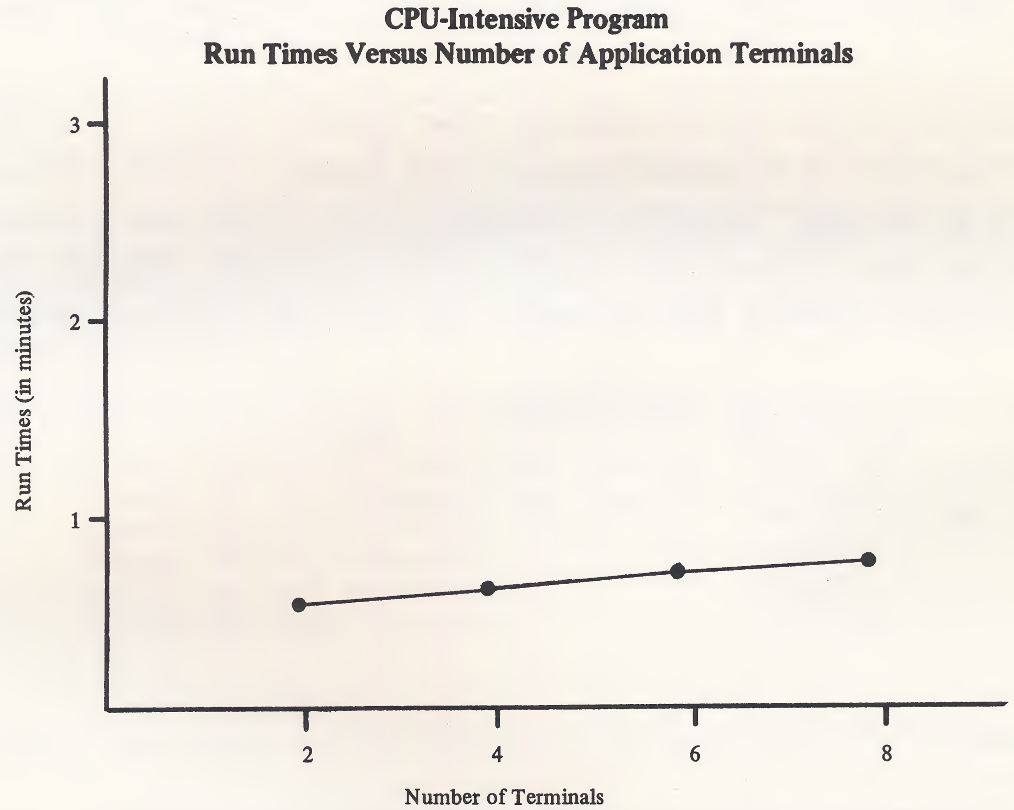
D-1	Results:	2 terminals	3.1 seconds
D-2		4 terminals	3.2 seconds
D-3		6 terminals	3.8 seconds
D-4		8 terminals	4.0 seconds

Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal

BENCHMARK TIMINGS: ALPHA MICRO AM-100T





activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order entry program running at the same time. Again, the measured times for the order entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order Entry Program
E-1	Results:	2 terminals	33.4 seconds	3.8 seconds
E-2		4 terminals	37.0 seconds	4.0 seconds
E-3		6 terminals	42.6 seconds	5.1 seconds
E-4		8 terminals	45.2 seconds	5.7 seconds

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order entry program for 2, 4, 6 and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-intensive job.

Note that in all cases, adding terminals slows response times. In production mode, moving from 2 to 8 terminals causes a 29% degradation in the processing time for a transaction. In program development mode, a 50% degradation is displayed as the number of terminals is increased from 2 to 8, while the CPU-intensive program showed a 44% degradation over the same range of terminals.

It is worth noting that the times reported are transaction processing times, not per line processing times. On a per line basis, the average response time per line, for say the E-4 test, would be .48 seconds.

SYSTEM AS TESTED: AM-100T

Costs

The Alpha Micro AM-1051 includes:

- AM-100T central processor
- 64 kilobytes of error-correcting memory
- Floating point hardware and a real-time clock
- One parallel and two serial I/O ports
- 90 megabyte hard disk drive
- System software and languages
- Documentation

Total Package Price	$23,675

With the addition of

• (3) 64 kilobyte ECC memory boards	$ 7,200
• (2) AM-300 6-port serial I/O boards	$ 1,700
• A Lear-Siegler ADM-3A+ terminal	$ 950
• TI 820 printer	$ 2,155

Total System Price	$35,680

Note: The system we tested used dual Trident drives rather than the Phoenix drive.

Our Observations

Additional terminals could be any non-intelligent terminal the user wishes to purchase. We have priced in the Lear-Siegler ADM-3A+ terminal (at $950 per terminal). The prices given below include the two AM-300 I/O boards (for a total of 14 available ports) and additional ADM-3A+ terminals.

Configuration	Total Price
System with one terminal	$35,680
System with two terminals	$36,630
System with four terminals	$38,530
System with six terminals	$40,430
System with eight terminals	$42,330

Note: All prices include Alpha Micro system software and languages.

Summary of Equipment and Features

- The AM-100T is a 16-bit processor which can employ 8-bit and 16-bit data transfers. The CPU is housed in an enclosure which contains a card cage and 19-slot motherboard.

- The AM-1050 system employs the AM-100 processor, a less powerful processor. The AM-100 CPU is housed in the same enclosure as the AM-100T.

- Memory for the AM-100T is supplied in 64 kilobyte increments up to a limit of 1024K. This memory is ECC or error-correcting memory and is capable of correcting single-bit errors and detecting double-bit errors ($2,400 for a 64K board). The 64 kilobytes are organized as 32K 16-bit words.

- The AM-100 processor uses standard parity memory organized as 64K bytes ($2,000 for 64K).

Our Observations

The AM-100T uses a bank-switching technique to extend its addressing capabilities. To define and allocate memory banks, each 16K segment on a 64K board must have switches or jumpers set to physically set the memory address that it will occupy when the memory bank is active. The user then defines and allocates this memory in the system initialization file (SYSTEM.INI) using MEMDEF and JOBMEM commands.

The operating system (AMOS) resides in an area of memory called sharable or non-switchable memory. Sharable memory is that portion of memory which can be accessed and used by all jobs on the system and may contain, in addition to the operating system, any other system or user programs to be shared by all jobs on the system. Programs that are located in the shared memory must be re-entrant programs, or programs that can be used by more than one user at a time. Because shared memory is considered to be a part of the 64K maximum available to any one user, the actual size of any user memory can never be more than 64K minus the size of sharable memory. Typically, the sharable portion will be 16K with no system programs (besides AMOS), 32K if RUN.PRG (the runtime interpreter) is in system memory, and 48K if BASIC.PRG (the BASIC compiler) and RUN.PRG are both in system memory.

Nearly all the users we talked to in our survey were using the AM-100 processor. They were happy with the processing capabilities of their system, with a number of users stating that the performance was outstanding for the price.

User Comments

. *For the cost, I don't think you can beat it.*

. *It's a big system for the price of a little system.*

. *I'd like to see virtual memory and paging.*

STORAGE DEVICES

Summary of Equipment and Features

- The standard AM-1051 package features a CDC Phoenix hard disk drive. This drive offers 90 megabytes of on-line storage, 15 megabytes of which are a removable cartridge. Priced at $11,675 without controller ($14,175 with controller), up to four drives may be put on a system.
- If less storage is needed, the AM-1031 package can be purchased. This system differs from the AM-1051 only in the hard disk capability provided. The AM-1031 offers the CDC Hawk hard disk drive with 10 megabytes of storage (5 megabytes removable). Up to four of these drives may be put on a system (priced without controller at $7,125; $9,125 with controller).
- Trident drives are also available on the Alpha Micro from some dealers. Though no longer featured by Alpha Micro, these drives are still fully supported by the company (dual 80 megabyte Tridents cost $28,400).
- The AM-210 dual floppy disk system is available for the Alpha Micro. Featuring double-sided, double-density drives for a total storage capacity of 2.5 megabytes, this system costs $5,000.
- Magnetic tape subsystems are also available on the Alpha Micro. Up to four of these nine-track, 800/1600 bpi systems can be used. Price for the transport and controller is $19,200.

Our Observations

The amount of storage that can be supported by an Alpha Micro system is impressive. One CPU can support up to four tape drives, up to eight hard disk drives (which translates to up to 2,400 megabytes of on-line disk storage), and two or more floppy disk drives.

Our tests showed the Trident drives to be more than adequate for any business application. Most of the users we talked to in our survey were using the CDC drives, either the Hawk or the Phoenix. Except in a couple of instances, all reported great reliability from their CDC drives. This was not always the case with the floppy drives though, where numerous complaints of down-time were recorded.

User Comments

. *Storage is unlimited . . . just add another Phoenix.*

. *Had only the usual amount of problems.*

. *I had major problems with the floppies . . . put the system down for nearly three weeks.*

. *Started out with the floppies and had tons of problems. Finally went with the hard disk and am quite happy with the reliability and performance.*

Summary of Equipment and Features

- Though Alpha Micro does offer a terminal to be purchased with their system, basically any standard RS-232C compatible non-intelligent terminal can be attached to the system. Prices for this type of terminal generally start at $600.
- As is the case with terminals, a variety of printers may be attached to an Alpha Micro system. In addition, Alpha Micro offers the AM-320 line printers. Offering a choice of 64 or 96 character set print bands and other features, the 320 comes in 300, 600, and 900 lines-per-minute versions (prices are $9,200, $12,500, and $20,000 respectively).
- Alpha Micro offers two I/O boards, the AM-300 and the AM-310. The 300 (used in our tests) is a 6-port, interrupt-driven, serial I/O board priced at $850. The 310 is a 4-port synchronous/asynchronous board which is also priced at $850.
- At the time of this writing, Alpha Micro does not offer IBM emulation (though we were told that bysync emulation is under development).
- Alpha Micro does offer system expansion by linking CPUs. Through the use of AlphaLINK, up to 8 CPUs can be connected.

Our Observations

By not requiring a particular terminal to be used on their system (as many manufacturers do), the Alpha Micro gives the user a great deal of flexibility in choosing terminals to be used. As we mentioned earlier in this report, AM system software (such as VUE) helps to make standard "dumb" terminals as useful and efficient as the much more expensive "smart" terminals.

This same flexibility is also true of printers. The users in our survey were using a variety of printers depending on their own particular printing needs.

AMOS allows the definition of what are defined as pseudo terminals. These pseudo terminals are actually terminal drivers which are a part of AMOS (they are called PSEUDO and NULL), and allow for jobs that may not actually be physically connected to any terminal (such as a spooler or other inter-program communication).

User Comments

. *I like the fact that I can buy nearly any terminal I want.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- Alpha Micro system software consists of the Alpha Micro operating system (AMOS), a three-pass assembler, linkage editor, symbol file generator, symbolic debug routine, and file management functions. Other system software includes three high-level languages (AlphaLISP, AlphaBASIC, and AlphaPASCAL), a word-processing system (composed of a text editor, VUE, and a text formatter, TXTFMT), and other utilities, support, and test programs.
- All Alpha Micro system software is included in the price of the system.

Our Observations

The Alpha Micro employs what we might call a "standard-approach" operating system. That is, it uses a command language (or JCL, Job Control Language), which is entered on a line-by-line basis rather than chosen from a menu of possible commands. A HELP command is available to provide information to the user on some AMOS commands.

AMOS is a multi-tasking, multi-programming operating system. The multi-tasking concept implies that the system can handle more than one task per user at the same time while multi-programming means multiple users may be running different programs at the same time.

To help insure file and system security, AMOS assigns account numbers and (optional) passwords to each user. Thus to "log onto the system," a user must type in his or her account number and password. A user may have one or more accounts, and each account has a directory of files associated with that account. Files in a particular project can only be accessed by those users associated with that project. We felt that this account number system would help to maintain system security, but did find that because one must be "logged on" to a particular disk in order to retrieve files from that disk, switching disks and/or projects can tend to quickly confuse the novice Alpha Micro user. Happily for us, when we did get mixed up, simply typing in the LOG command will identify the currently logged project and disk. A couple of other nice features of this account system are:

- Upon logging into an account, a program can be automatically called and execution begun without requiring further commands to be entered by the user.
- A message of general interest may be displayed to all users as they log on.

One of the most useful features of the Alpha Micro operating system is the ability to create and execute command files. Command files are files of AMOS commands, command options, and special symbols which are executed when the command file name is entered. A special type of command file (called DO files) allows the user to pass arguments (such as file names) to the command file.

Command files are extremely prevalent throughout the AMOS system. They are used in a variety of applications including system initialization (where the system initialization process uses a command file called SYSTEM.INI), the log-on procedure (where a START.CMD command file is executed upon logging on), and the HELP command. By creating command files, a user can design a single command which will execute a whole series of AMOS commands. We found this especially useful in our benchmark testing where we had to repeat a series of commands to re-initialize for each run of our order entry benchmark.

Another feature of the operating system we particularly liked was the text editor called VUE. We found VUE to be a powerful full-screen editor which makes creating text files of any sort (e.g., source code) an easy and efficient process. Perhaps the biggest advantage of VUE is the fact that its full-screen editing capabilities do not require an expensive intelligent terminal (as on many systems), but rather can be used on nearly any less expensive "dumb" terminal.

The users we talked to in our survey were generally very pleased with the AMOS system and associated utilities. They were pleased with its speed of operation, enjoyed the command file capability, and thought that, all in all, AMOS was a quite satisfactory system. There were, however, some complaints about inexplicable system "crashes" and "lock-ups" often associated with the usage of VUE. Many users felt that a lack of safeguards contributed to these system "crashes."

User Comments

- *The operating system is excellent. It's ten times better than any other micro I've looked at.*
- *Very pleased with AMOS.*
- *VUE is super . . it's really a nice feature.*
- *VUE is fair to good. Sometimes when we edit a big file, it seems to destroy the system and we have to reboot.*
- *It crashes more than I think it should.*
- *Speed is adequate for my purposes.*
- *VUE? I love it. If it were single, I'd marry it!*
- *AMOS gets a B+ . . . not too bad.*
- *AMOS is very sophisticated. There's no great burden on me to derive an operating system . . . all I need do is application programming.*

Summary of Features

- Included with the Alpha Micro system software are three high-level languages: AlphaBASIC, AlphaPASCAL, and AlphaLISP.
- Alpha Micro does sell a business accounting system which consists of five integrated modules and a set of subroutines. The modules are:

  - General Ledger
  - Accounts Receivable
  - Payroll
  - Accounts Payable
  - Order Entry/Inventory Control

  This accounting package is not designed as a turn-key package, but is intended to be customized by an experienced programmer/analyst. Alpha Micro offers no support for the package other than program source code and documentation.

Our Observations

We found AlphaBASIC to be an enhanced implementation of BASIC with a number of features that make it particularly suitable for business application programming. Some of these features are:

- Support of floating point hardware for fast numerical computations.
- Unlimited length variable names.
- A "memory mapping" system that provides a way of defining entire groups of related information (like logical records). This feature is much like COBOL data definition techniques.

AlphaBASIC is a compiled BASIC, but does offer an interactive type of environment. Though code is still being compiled in the interactive mode, immediate statement execution is possible and the programmer can interrupt the program to display and/or change variables used by the program. We found that most experienced users opted for VUE to create source code and would use the interactive mode for program debugging. We must admit that we prefer a situation where a programmer can be in one mode that is interactive (for debugging and immediate execution) and also has a good editor for source code modifications. This type of system helps speed up program development by eliminating the need for going back and forth between an editor and the compiler/interpreter.

Users were generally happy with AlphaBASIC and the other languages available on the system. Users who had the Alpha Micro accounting package often felt that even though it is intended only as the basis of a system, it was a little too crude and required too much modification.

User Comments

- *Languages are fair. Had trouble with the PASCAL compiler.*
- *Best BASIC I've ever seen. MAP statements are really helpful.*
- *All the packages from Alpha Micro had to be grossly modified.*

Summary of Features

- Hardware maintenance is offered primarily through the Alpha Micro dealers. Alpha Micro does offer a 120 day limited warranty on the hardware.
- Software service is offered again primarily through the dealers. AM offers an update service for their system software. Releases are sent on a semi-annual basis and the cost of a new release varies from $25 to $350 depending on the type of media used.
- There is a user's society called AMUS (Alpha Micro Users Society). With about 900 members now and annual dues of $35, the group offers monthly newsletters, seminars, and annual meetings.
- Included with an AM system is a full complement of documentation on the system software.

Our Observations

We found the Alpha Micro documentation to be very good and quite helpful. Users, as we've often found to be the case, expressed a variety of opinions on the documentation. Their comments ranged from singing the praises of Alpha Micro manuals to complaints about the sketchiness and lack of information in them. There was agreement, though, among those users who had owned their system for a year or more. Their consensus was that the documentation was vastly improved from what it had been, and was constantly getting better. Our own experience seems to confirm this opinion with regard to the AlphaBASIC manual. During our benchmark testing, we felt the version of the manual we were using was unsuitable both as a reference and as a guide to become acquainted with AlphaBASIC. But then, during the writing of this report, we received the new version of the manual and found it to be vastly improved and much more helpful.

User relationships with their dealers varied from some who expressed great satisfaction to many who were less than pleased.

User Comments

- *Documentation seems to be their biggest problem.*
- *The manuals were weak two years ago, now they're quite complete.*
- *The documentation is good and getting better . . . 50 times better than it has been in the past few years.*
- *My local dealer is good.*
- *Dealing with my dealer has been most unsatisfactory. They are unknowledgeable, and lack competency and professionalism.*
- *If I had to do it over again, I'd be sure to find someone familiar with my application and that already had the software for it.*
- *The factory is the weak spot. They try to insulate themselves from the public, which they shouldn't do because not all dealers are that knowledgeable. They're being hard-nosed about it and turning people off . . . that's too bad because it's a great system.*

SUMMARY OF USER COMMENTS

We contacted 15 users of the Alpha Micro using names supplied by the Alpha Micro Users Society and the Association of Computer Users. The AM system is being used by a variety of companies including distributors, equipment leasing firms, a vocational school, land title insurance firm, a commercial printer, and an electric power plant. In addition to the standard accounting applications, about half were using the Alpha Micro for financial reporting, database management, and word processing. In nearly all cases, the system was being used at least eight hours a day, five days a week.

With the exception of one user who had the AM-100T processor, all those we contacted were using the AM-100 processor with from 64 to 320 kilobytes of central memory. Most users had at least one hard disk while some had dual floppies in addition to hard disk storage. Hard disk drives consisted primarily of CDC Hawk and Phoenix drives while the floppies were generally Persci or Wango. Printers in use included Diablo, Teletype, and Texas Instruments and CRTs were primarily Soroc or Hazeltine.

Before buying the Alpha Micro, the users we surveyed had considered such systems as Radio Shack, Data General, HP, Xerox, IBM, Honeywell, Ohio Scientific, and Wang. The main reasons reported for buying the Alpha Micro were price, the 16-bit CPU with the S-100 bus, and the multi-user/multi-tasking capability. Interestingly, some of the users had bought the Alpha Micro on advice or "word of mouth" without evaluating other systems.

Hardware problems were considered to be "normal" or "minor," with the most problems occurring with the floppy disk drives (especially the Persci's). Service for the hardware was provided by the dealers with the quality of service reported to be generally good; a few users did feel it could be better.

The Alpha Micro operating system (AMOS) was very well liked. As one user said, "There's no great burden on me to derive an operating system . . . all I need do is the application progamming." One area of dissatisfaction that was expressed regarded the amount of memory available to the user (64K minus the size of the operating system, which many felt was too small and limiting.

Some of the users thought the system "crashed" too easily, especially when using VUE. Most felt the system did slow down in multi-user situations, but generally believed the processing speed was adequate for their purposes or shrugged it off as a limitation imposed by their own price constraints. (Note: These users had the slower AM-100 processor, not the AM-100T used in our tests.) Some users pointed to priority setting procedures and lack of safeguards as things they would like to see changed or added. Others thought a refinement or restructuring of the bank switching and memory partitioning could greatly enhance the system.

The AM text editor VUE received rave reviews. Though some problems were reported, most users were quick to add that with each release some of these were eliminated. All the users were more than happy with AlphaBASIC. Some inconsistencies were reported (which some thought could be a result of the documentation), but again, they were seeing problems solved and improvements made with each new release.

Of the users that had the Alpha Micro accounting package (about a third of those we talked to), the consensus was that the package was very basic, had a lot of "bugs," and therefore required "gross" and "extensive" modifications. Most admitted though that the package laid a "good groundwork for further programming."

About a third of the users we surveyed viewed their dealer as unsatisfactory in some way. Nearly half were filling their software needs in-house. Some felt that Alpha Micro could improve their public relations by being more willing to listen to and help end-users.

Documentation was often listed as a weak spot, especially the AlphaBASIC manual. As with the system software though, users reported that over the last couple of years, the documentation was vastly improved and getting better.

Overall, the 15 users we talked to were quite pleased with their Alpha Micro system. Despite slight inconsistencies in system software and variations in dealer performance, they felt the operating system, utilities, and AlphaBASIC were superior to other systems they had seen. Their comments often pointed to weaknesses or areas needing improvement in a system that they otherwise loved working with. Some users said they were selling AM's for their dealers simply by vouching for the system to prospective buyers. As one user said, "I'm probably their happiest customer."

CONCLUSIONS

In this, our sixth report in this series of Benchmark Reports, we have reviewed the Alpha Micro. We call it the "Alpha Micro" or the "AM-100T," because the packaged systems available from Alpha Micro are essentially the same except for the choice of disk storage to be used. All the packages use the same AM-100T processor (or the AM-100) and a S-100 bus. We often refer to the AM-1051 package in our report, as this is the package we felt to be appropriate for this series of reports.

The Alpha Micro computer system is a versatile system that we found to be adaptable to a wide range of business types and sizes. Perhaps one of its best advantages is its easy expandability. A user can start out with a one or two terminal system, maybe 10 megabytes of hard disk (all for a relatively low price) and expand storage and terminals as needed, without changing operating systems, languages or even much of his application software. So, from a relatively small system the user, if he wishes, can expand to 24 terminals and printers and 2400 megabytes of hard disk storage.

We found Alpha Micro system software to be the strong point of the AM system and the reason the AM gives the appearance/performance of a much larger system, yet at a low price. As an example, the text editor VUE (a very good full-screen editor) runs on standard "dumb" terminals rather than the more expensive "smart" terminals required on many other systems. Thus, a user can expand the system's multi-terminal capability at relatively little expense. (In fact, the eight terminal price for the AM is the lowest of the first six systems we've tested.)

The users we contacted in our survey were generally quite pleased with their Alpha Micro system. They reported few hardware problems and cited the system software as their area of greatest satisfaction. Though complaints about system "bugs" and some documentation "inconsistencies" were reported, most users were quick to add that they felt AM was doing a good job of correcting and improving the software. As is not uncommon in our surveys, the greatest area of dissatisfaction was in the area of the user/dealer interface. Some users expressed the feeling that more involvement with and understanding of user problems on the part of Alpha Micro itself might go a long way toward relieving this problem.

A reliable, easily expandable machine, the Alpha Micro system is meeting the needs of a variety of business uses, at an affordable price.

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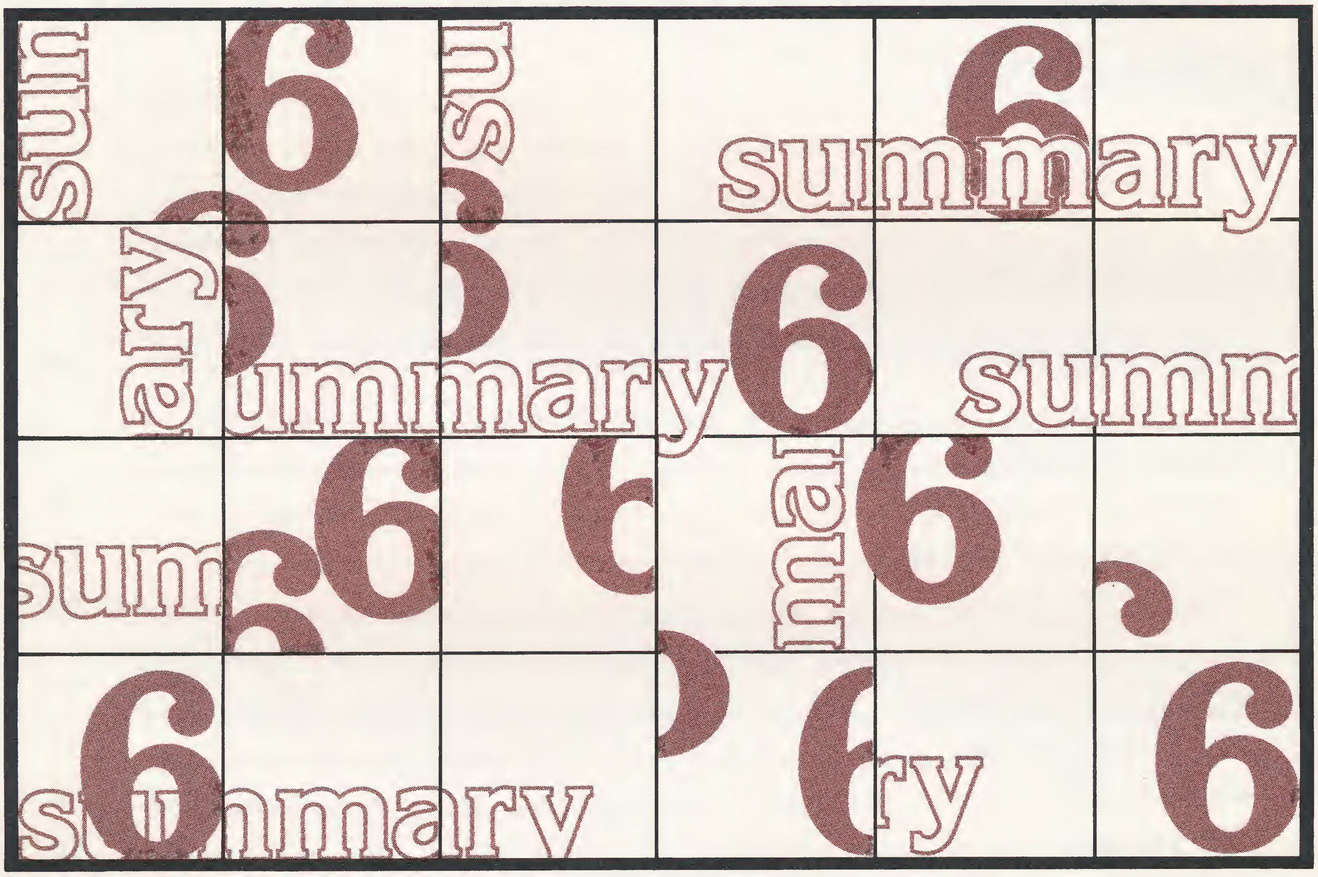

6 Issue Summary

- *DEC DataSystem 355*
- *WANG 2200MVP*
- *IBM Series/1*
- *TEXAS INSTRUMENTS DS990 Model*
- *HEWLETT-PACKARD Model 250*
- *ALPHA MICRO AM-100T*

SIX-ISSUE SUMMARY REPORT

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PREFACE

Over the last few months, the Business Research Division has gathered information on six computer systems in the $25,000 to $50,000 price range. This information, presented in our BENCHMARK REPORTS, consists of benchmark timings, price and configuration information, firsthand observations by our benchmark team, and the comments of users whom we have surveyed. It has been designed to help a prospective purchaser to choose from among the many possible alternatives.

The focus of our benchmark timings for these multiple-user systems involves measuring the response time of the various systems in a standardized order-entry benchmark designed by our analysts at BRD. Using a Remote Terminal Emulator (RTE) to simulate up to eight users of the order-entry system, we can measure the amount of time each system spends processing the order-entry application. As we vary the number of terminals and add a background job (to simulate background development work), we can see how each system responds to the benchmark workload. In addition to the response timings, we run two programs which provide information on CPU and disk access speeds and are directly comparable with timings done in Series 1 and 2 of the BENCHMARK REPORTS.

In addition to this quantitative data on performance, we have also reported price-performance comparisons, storage capabilities of main memory and peripherals, and other technical specifications of the equipment. Finally, we have provided our own personal observations on various less quantifiable factors such as ease of use, problem areas for the novice user, documentation and support quality, and human/computer interfacing. We have also included in each report comments from users of the system. Their observations and experiences with the equipment prove invaluable in separating "myth" from "fact" in manufacturers' technical specifications.

The purpose of this summary report is to highlight the key points discussed in the first six reports. It should be noted, though, that in any summary, some simplification is necessary and unavoidable. Each of the systems we have tested offers many options, configurations, and tradeoffs which the user must consider in any purchase decision. This summary, then, will highlight the differences among machines (when they occur), but for more in-depth information, the reader is encouraged to refer back to the individual reports.

	DEC Datasystem 355	WANG 2000MVP	IBM Series/1	TI DS990 Model 4	HP 250	Alpha Micro AM-100T
COST	$43,550	$34,500	$52,375	$36,635	$30,350	$35,680
MEMORY						
Maximum	256K	256K	256K	2048K	576K	1024K
Type	Parity	Parity	Parity	ECC	Parity	ECC
SECONDARY STORAGE						
"Standard" Hard Disk Capacity	10.4 MB	5.0 MB	9.3 MB	9.4 MB	12.1 MB	90 MB
Expandable to:	224 MB and up	484 MB and up	258 MB and up	676 MB and up	53 MB	2400 MB
Floppy Disk	Yes	Yes	Yes	Yes	Yes	Yes
Mag Tape Cap.	Yes	Yes	Yes	Yes	No	Yes
COMMUNICATIONS						
Max. No. of Terminals	8	12	P.L.	39	6	24
Synchronous Capability	Yes	Yes	Yes	Yes	Yes	Yes
IBM Emulation	Yes	Yes	Yes	Yes	Yes	No
SOFTWARE						
Operating System	Line Oriented	BASIC lang.	Line/ Menu	Line/ Menu	BASIC lang.	Line Oriented
Languages Available	DIBOL	BASIC	EDL,P1/1 FORTRAN, COBOL	FORTRAN, BASIC, PASCAL COBOL, RPG, TPL	BASIC	BASIC, PASCAL, LISP
Languages Tested/Type	DIBOL; Batch	BASIC; Inter-active	COBOL; Batch	COBOL; Batch	BASIC; Inter-active	BASIC; Batch
Mfg. Packages	Some	Some	None	None	Some	Some
Vendor Packages	Extensive	Extensive	Extensive	Extensive	Extensive	Extensive
Documentation	Satis-factory	Satis-factory	Complex	Satis-factory	Above Average	Above Average
Distribution	Direct/ OEM	Direct	Direct	Direct/ OEM	OEM	OEM

NOTES ON OVERVIEW

- ECC memory is error correcting memory. This type of memory is capable of correcting single-bit errors and detecting double-bit errors.

- The "standard" hard disk capacity implies with the amount included in the basic "package" or the "standard" amount as determined from our user survey.

- Note that the amount of storage available on the Alpha Micro far exceeds that of the other systems, yet at a cost that puts it in the middle of the systems' prices. If the CDC Hawk drive were priced in (a 10 megabyte drive), the system would cost even less (approximately $5,000 to $6,000 less).

- Hard disk storage expandability on the Wang, IBM, and TI systems is quite large, and basically just a function of the number of card slots available for the disk controller boards. The DEC's upper limit is 224 megabytes unless the user upgrades to the CTS-500 operating system.

- The maximum number of terminals for each system is really a function of the particular user application and may or may not be as large as the number given. The "P.L." indicates that the system's physical limit far exceeds any "realistic" or "practical" limit (as determined by the application itself).

- We are defining Batch and Interactive language types from a user's perspective. If a Compile-Link-Load-Execute sequence is required (or a subset of that sequence), we have defined the language as Batch. If execution begins immediately with a RUN command, we described the language as interactive. Admittedly, some languages may offer features found in both modes (e.g. AlphaBASIC) by emulating an interpretive environment, but if a separate step (or steps) was required by the user before executing the program, we defined the language as Batch.

- It is interesting to note that the three fastest machines in our benchmark timings (the HP, Wang, and Alpha Micro) were all using the BASIC language. Traditionally it has been held that interpretive languages (like BASIC) are slower executing languages than compiled languages, but this has not been the case in our benchmark tests.

THE BENCHMARK PROCESS

While there are a number of factors involved in evaluating a computer system--languages, operating system, applications software, maintenance, and supplier support--everyone asks for some single measure of system performance on which to base comparisons. When the performance question is asked, the answer is often a technical one--MIPS (millions of instructions per second), disk access speeds and transfer rates, channel speeds and capacity, etc. The problem with these measures is they have little basis in the reality of the application for which the system will be used.

In his excellent article on the measurement of computer throughput ["Tracking the Elusive KOPS," by Edward J. Lias, in Datamation, November, 1980, pp. 99-105], Lias discusses MIPS and KOPS (thousands of operations per second) and notes that they are measures of processor speed but not computer throughput. Throughput depends not only on processor speed, but on the efficiency of the compiler, the operating system, the power of the instruction set, the job mix, and peripheral performance. He concludes that there is one factual and reliable measurement which can help in choosing from among the systems available--benchmarking, which focuses on actual throughput and output.

Benchmarks are based on computer programs designed to run, without change, on a number of different computing systems. There are two principal criteria used in the design of benchmark programs: the job/instruction mix to be tested, and the ability to compare across systems.

- The job mix is the set of programs which represent the general activities in which the user is interested. For example, ACU's benchmark programs test raw computing power through the CPU-intensive program, disk access through the I/O-intensive program, and multi-terminal response through the Order-Entry program.
- Within each program, the particular mix of instructions must be determined. Since the order-entry application had a specific sequence of actions to perform, the set of instructions was well defined. The I/O and CPU programs required an explicit definition of the statements which would measure those raw computing capabilities of interest.
- To maintain the ability to compare across systems, the choice of tests must be restricted to the set of capabilities found on the majority of computers to be tested. Those things which a system can do in addition to the minimum procedures are then considered "extras" in the evaluation process.

The single user CPU- and I/O-intensive programs used in this series of reports are identical with those used in the Series 1 and Series 2 reports, and are included to provide comparability with those computers costing under $25,000 in a single user configuration.

- CPU-Intensive program. This particular program is predominantly a test of two specific functions (exponentiation and root) which would be used in numeric computations of a more scientific nature. While we can't point to a specific application for which this is a representative program, it does measure the care with which each manufacturer has implemented scientific functions.
- I/O-Intensive program. This program reads and writes, sequentially, a set of numbers on the disk. Sequential access was chosen since this was the only method available on many of the small systems. Additionally, the purpose of the test is to measure disk access speed--a combination of head movement, storage capacity, and data transfer rates--and sequential access provides the purest measure of this.

The remaining program was designed specifically for testing multi-user capabilities in a real-world application.

- Order-Entry program. This program, using three indexed-sequential files, processes orders, and outputs shipping documents and invoices. Run with two, four, six, and eight terminals inputing orders, and repeated with the CPU intensive program running in the background, it measures degradation in response as terminals are added to the system.

  In order to measure this response time, we have developed a computer program which runs on a North Star Horizon and emulates up to eight remote terminals communicating with the test computer (our Remote Terminal Emulator, or RTE). The RTE feeds a script to the test computer and measures response times for each prompt.

  There are three characteristics of the RTE which are important in interpreting results.

  1. Communications between the RTE and the test computer run at 30 characters per second. Thus, a computer with zero processing time would still be measured at 0.9 seconds response time per transaction (11.8 input lines each) due to communication channel delays.

  2. While we report response times to the nearest tenth of a second, they are measured to the nearest hundredth. Measurement error could be as large as .12 seconds per transaction. However, because we are effectively sampling from 22 to 88 transactions, we would expect the error to be much smaller.

  3. There is some variability in the response of the computer under test. We do perform selected re-timings, and gross errors would be obvious from the graphs included in each report.

USING BENCHMARK RESULTS

The effective evaluation of a computing system involves the consideration of a number of criteria including, but not limited to, our benchmark system results. Though these results provide important information in evaluating the processing capabilities of a computer system, other factors included in the body of our reports must also be considered. Some of the criteria we consider important in the evaluation of a computer system are listed on the following three pages. Alternative systems should be rated on these criteria and compared against the system requirements (as set by you, the prospective purchaser) before a final choice is made.

One method we have found useful for the evaluation process consists of the following two steps:

1. Set certain minimum standards or capabilities, and any alternatives not meeting the minimum will be eliminated from further consideration. For example, COBOL may be a requirement, and any system not having this capability will be eliminated.

2. After application of Step 1, a set of systems will be left from which a final choice will be made. A weighted rating scheme, where weights are placed on each of the criteria to indicate their relative importance to the buyer, will be used to evaluate the remaining systems. Each system is rated on the criteria (here is where our benchmark results become important) and a single score on which each alternative system can be compared is computed by finding the sum of the weights times the ratings.

This two-step scheme implies that tradeoffs can be made among the various attributes of a system, and an excellent score on one attribute can compensate for a poor score on another. For example, a vendor rated high on service but low on documentation can still achieve a high overall score, particularly if service is considered more important than documentation.

Using this process, the system which is most suitable for the user should be the one with the highest score. For this process to be valid, though, particular care must be taken in assessing the weights placed upon the various criteria. These weights should reflect careful consideration of system requirements unique to your organization and should be assigned prior to any evaluation of specific systems. Prior assignment of these weights will help to insure that the analysis of the processing needs of your business will be unrestricted by the knowledge of the capabilities/limits of any particular system.

As we've examined the six systems in this series of reports, we've compiled a list of areas which we feel require particular attention when purchasing a computer system in this size/price range. Our list includes these items:

1. System expandability. What is the growth potential of your firm? What does this imply about the growth needed in your data processing capabilities? How does this translate into the number of terminals and amount of disk storage that will eventually be needed?

2. Components versus a Package. Your answer to this question will greatly depend on your answer to question 1. More expandability may sometimes be found by putting together your own system (via selection of the various components) rather than buying a packaged system, but the selection of the components may not be an easy task.

3. Programming. Who's going to program the machine for you or will it be a "turnkey" system? If in-house programming is included, then special attention to the program development mode must be paid.

4. Software portability. As your business does expand, sooner or later you will have to buy a new, bigger/faster system. What will happen to all the software you've purchased/developed and have finally gotten used to? The question is, then, "Will the software I develop or buy for this system work on the next system I buy?"

The computer purchase decision is not an easy one. Careful analysis of your business' needs followed by thoughtful evaluations of the systems available is required. It is our intention that these BENCHMARK REPORTS help to provide a solid base of information for this decision. We hasten to add, though, that simply reading these reports is not enough. The prospective purchaser must talk to vendors, manufacturers, and even present system users to find out the details that we can't report, such as: Who is the local vendor? Is he reputable? How long a wait for delivery? What types of financing are available?

If all this sounds like it will take some time and effort, that's true! The prospective computer buyer must be willing to put in the effort to make a knowledgeable choice. Supplementing your own time and expertise by hiring a consultant to help with the system analysis and computer evaluations is a viable option for those who cannot devote the time required. The warnings we've given about selecting a computer vendor apply equally to consultants. Be sure the consultant's "expertise" is worth the price. Check references carefully and agree beforehand on just what he will and will not do for you. Remember, his knowledge will not make the decision, you must make it alone.

HARDWARE CRITERIA LIST

Weight	Score	W x S	
			Processing Capability
			Response Time
			Transaction Volume
			CPU
			Printer
			Current Capacity
			Memory
			Disk Storage
			Peripherals/Channels
			CPU
			Cost
			System
			Components
			Shipping
			Installation
			Expansion
			CPU
			Memory
			Disk
			Tape
			Printers
			I/O Devices
			Other Peripherals
			External Interfacing
			Documentation

HARDWARE CRITERIA LIST (Continued)

Weight	Score	W x S	
			Warranty
			Length
			Service Provided
			Service
			Cost (contract/hourly)
			Travel
			Response Time
			Services Provided
			Site Preparation
			Special Requirements
			Costs
			Ease of Operation
			Ease of Installation
			Assistance Provided
			Training Provided
			TOTAL WEIGHTED SCORE

SOFTWARE CRITERIA LIST

Weight	Score	W x S	
			Operating System
			Flexibility
			Ease of Operation
			Languages
			BASIC
			COBOL
			Other ______________________
			Other ______________________
			Systems Utilities
			Editor
			Report Generation
			Monitor
			Applications Packages
			Accounting
			Inventory
			Mailing List
			Other ______________________
			Documentation
			Warranty
			Service
			Upgrade/Maintenance
			Sales/Rental
			Ease of Implementation
			Installation Checkout
			Training Provided
			File Management Capability
			TOTAL WEIGHTED SCORE

CPU-INTENSIVE PROBLEM

PROBLEM STATEMENT

These two programs execute a variety of calculations. The first program (A-4) uses addition, multiplication, division, square root, and exponentiation. Because not all of the systems we tested have the square root and exponentiation functions, we also ran a second program (A-8) which uses just addition, subtraction, multiplication, and division. Each time reported is for an iteration of 3000.

RESULTS (in seconds)

Program	DEC Datasystem 335	WANG 2200MVP	IBM Series/1	TI DS990 Model 4	HP 250	Alpha Micro AM-100T
A-4		15.2			24.7	31.4
A-8	38.8	13.0	4.9	110.3	20.4	

OBSERVATIONS AND COMMENTS

- Though the Series/1's compile-link-load-execute sequence to generate executable COBOL code is a time-consuming process, the code generated is fast, as indicated by its timing on the A-8 test.
- The three systems for which we do not report an A-4 timing used either COBOL (IBM and TI) or DIBOL (DEC) which do not include exponentiation and square root functions.
- TI's COBOL version of the CPU-Intensive program produced the slowest timing of the systems we've tested. When re-written in TI's PASCAL and FORTRAN, the times were cut approximately in half.

PROBLEM STATEMENT

This program stores numbers from 1 to 3000 on disk and retrieves them in a factorial fashion (a total of 1276 reads follows 3000 writes).

RESULTS (in seconds)

	DEC Datasystem 335	WANG 2200MVP	IBM Series/1	TI DS990 Model 4	HP 250	Alpha Micro AM-100T
Program						
B-4	46.7	11.2	23.1	47.0	10.0	42.9

OBSERVATIONS AND COMMENTS

- The results of this I/O-Intensive test provide a basis of comparison between these six systems and the systems tested in our Series 1 and 2 reports. Some comparable times for three systems tested in the Series 1 reports which used hard disk storage include 28.4 seconds for the Cromemco Z-2H, 50.2 seconds for the Ohio Scientific C3-B, and 2 minutes, 20.4 seconds for the Data General CS10.

- The I/O-Intensive benchmark program performs sequential rather than random disk access in order to accommodate the capabilities of the less expensive systems tested in other series of BENCHMARK REPORTS. Thus, with this "common denomination" program, the difference in disk performance capabilities can be illustrated across a wide price range of systems.

- Wang's I/O-Intensive timing is not directly comparable to other I/O times presented above. This is due to the fact that Wang personnel rewrote this program with the net result of greatly reducing the number of reads and writes done on the file. Though reducing the comparability for our reports, this was a necessary and normal procedure when doing I/O on the 2200MVP.

"REAL LIFE" PROBLEM

PROBLEM STATEMENT

This program is based on an order-entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

D-1 through D-4 are "production mode" timings. In this mode, the order-entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system.

E-1 through E-4 are "program development mode" timings. This mode simulates a "typical" working environment where, in addition to normal production tasks (like the order-entry application), programmers may be developing or testing new programs. This is accomplished by executing the CPU-Intensive program continuously, with the order-entry program running at the same time. Measured times for the CPU-Intensive program to complete 3000 iterations of the computational loop are also reported in each individual report.

RESULTS (in seconds)

	DEC Datasystem 335	Wang 2200MVP	IBM Series/1	TI DS990 Model 4	HP 250	Alpha Micro AM-100T
Production Mode						
D-1 2 terminals	5.0	2.8	7.9	3.8	2.1	3.1
D-2 4 terminals	7.3	3.0	8.0	3.9	2.2	3.2
D-3 6 terminals	11.9	3.3	--[1]	4.0	--[2]	3.8
D-4 8 terminals	16.5	3.5	--[1]	4.3	--[2]	4.0
Development Mode						
E-1 2 terminals	7.5	3.5	--[3]	3.9	2.2	3.8
E-2 4 terminals	9.3	3.8	--[3]	4.0	2.3	4.0
E-3 6 terminals	13.5	4.1	--[3]	4.1	--[4]	5.1
E-4 8 terminals	16.1	4.6	--[3]	4.3	--[4]	5.7

OBSERVATIONS AND COMMENTS

- Because of memory limitations and some as yet unresolved program or system problems, we were unable to obtain a full set of timings for the Series/1.

- Though limited by a maximum of five remote terminals, the HP 250 turned in the fastest 2 and 4 port timings. This impressive showing was in part a function of the unique program structure designed by HP personnel for the order entry system. Employing a single program which treated the terminals as "devices," the HP was able to take advantage of some of its unique hardware and software features to produce these timings.

- All the systems that could run up to eight terminals with the exception of the DEC, showed little absolute degradation as terminals were added. This seems to indicate that for this particular application (our order entry system), eight active terminals does not "overload" these systems.

1 Could not be run due to memory limitations.

2 Five is the maximum number of remote terminals that can be run on the HP250. A 5-terminal test yielded a time of 2.2 seconds.

3 Could not be run due to an apparent loss of characters in the order-entry processing.

4 Five is the maximum number of remote terminals that can be run on the HP 250. A 5-terminal test yielded times of 2.4.

PROFILE: DEC DATASYSTEM 355

Price as Tested = $43,550

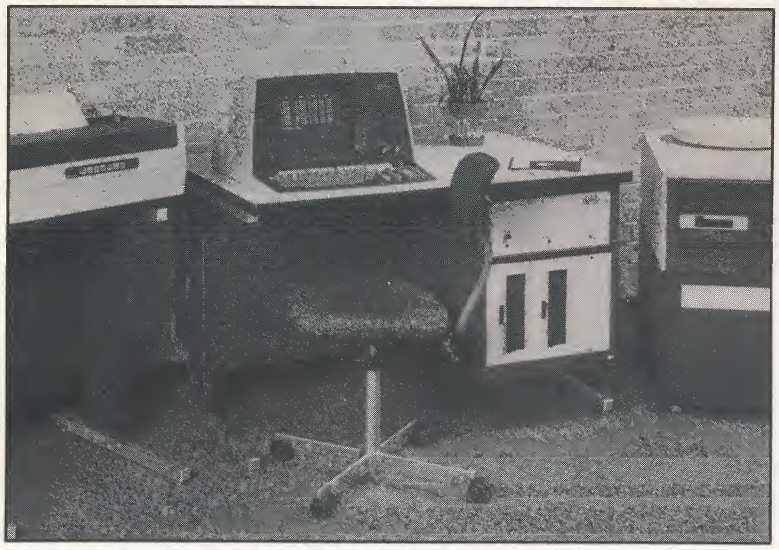
BEST FEATURES .... One of DEC's best features has to be DEC itself. A large, well-known company with many years of experience in the minicomputer field, DEC is known for producing reliable, quality systems. The DS 355 is one in a large line of systems based on the PDP-11 processor. Software compatibility among this line of systems is viewed as a large advantage by users of the 355, most of whom plan to upgrade within the DEC line.

DRAWBACKS .... Users did report some problems with the CTS300 operating system, though the latest version (version 5) has been well received. Though we did consider DEC's programming language DIBOL to be suitable for business application programming, we feel that its lack of transportability to non-DEC systems is a disadvantage.

CONCLUSIONS ...... Based on the PDP-11/34 processor, the DEC Datasystem 355 is a "packaged" system oriented towards the business user. With many software packages available from software houses and DEC, the 355 is being used in a variety of business situations. User satisfaction with the 355 is probably best expressed by their intention to upgrade within the DEC line.

PROFILE: WANG 2200MVP

Price as Tested = $34,500



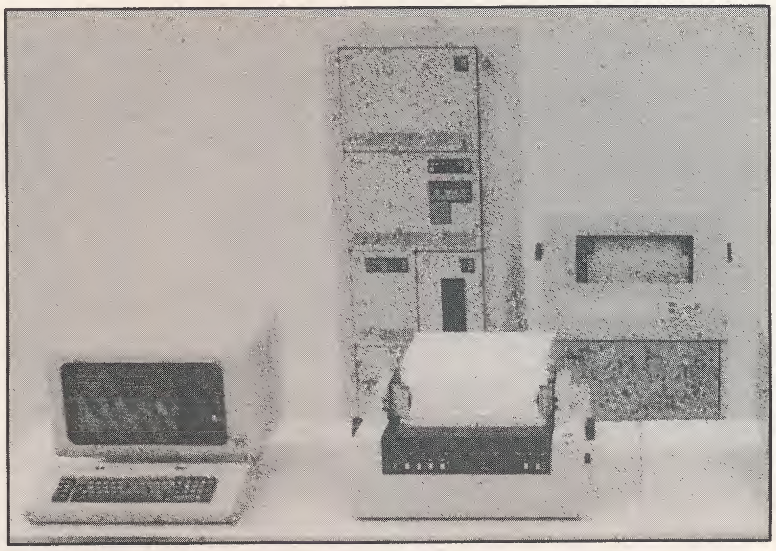
BEST FEATURES .... Our tests indicate the Wang is a fast machine. A well-designed operating system contributes to the 2200MVP's efficient handling of multiple users. A "BASIC language machine," the operating system is transparent to the user, who interacts with the system through the use of BASIC language statements and programs. With a powerful operating system and a highly enhanced interpretive BASIC, the 2200MVP is a pleasure to program.

DRAWBACKS .... We could find few drawbacks to the Wang system, either in our experience with the machine or from the users in our survey. The primary area of user dissatisfaction dealt with the manufacturer/user interface. A number of users felt that support from Wang, particularly in the early stages of installing the machine, was weak and/or non-existent.

CONCLUSIONS ...... We found the Wang 2200MVP to be a fast, well-designed multiple user machine. With an enormous amount of software available from third-party sources, and its easy-to-program characteristics, the 2200MVP is attractive to the "turnkey" purchases and "do-it-yourself" buyer alike.

PROFILE: IBM SERIES/1

Price as Tested = $52,375



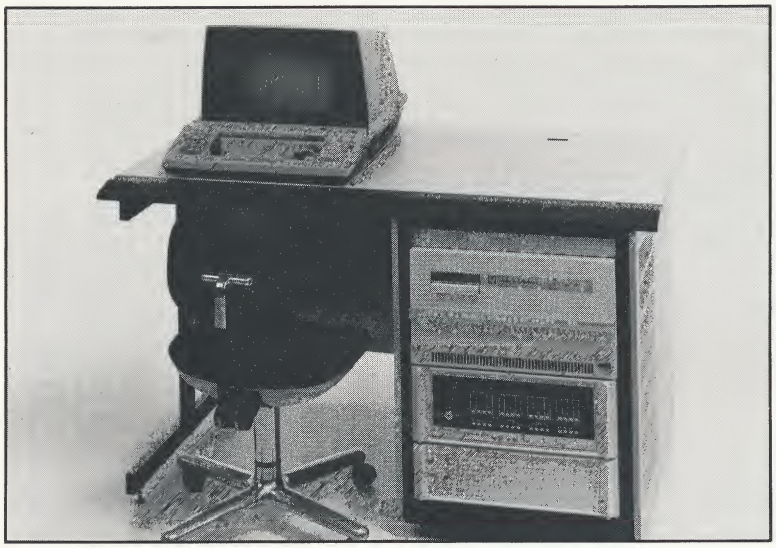
BEST FEATURES .... Versatility and modularity must certainly be highlighted as the best feature of the Series/1. From the hardware to the software, the Series/1 provides flexibility and an awesome number of possible hardware/software configurations and capabilities. In addition to its versatility, users applauded the Series/1 hardware reliability and IBM's service and support.

DRAWBACKS .... Not for the inexperienced if not packaged properly, the Series/1 versatility comes at the price of complexity. The Series/1 requires a lot of resource management by the user, it's not automatic. Thus programming the Series/1 requires competent, experienced programmers who are familiar with the IBM Series/1.

CONCLUSIONS ...... A "mini-mainframe" as we described the Series/1 in our report, it appears to the user/programmer much like a large IBM mainframe. For this reason, we feel that most users would be well-advised to purchase the Series/1 as part of a complete, "turnkey" system from a reputable, experienced vendor. If not purchased in this manner, the user should have, or be willing to hire, experienced programmers who can take advantage of the versatility of the Series/1.

PROFILE: TI DS990 MODEL 4

Price as Tested = $36,635



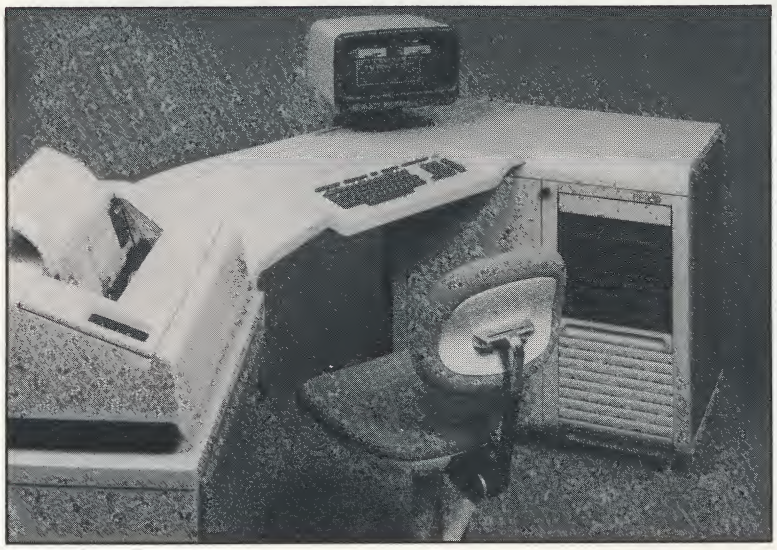
BEST FEATURES .... DX10, the 990's operating system, is one of the best features of the Model 4. A powerful multi-user system, its menu-driven approach and efficient utilities contributed to users' appreciation of the DS990's human interfacing. Users were also especially pleased with efficient and speedy service from the TI service organization. The variety and quality of the programming languages available on the TI were also given praise by the users.

DRAWBACKS .... Users registered very few complaints with the DS990 in our survey. There were some complaints with the documentation, though no real unhappiness was expressed with the quality and quantity of the manuals, just their organization. From our experiences with the machine, we did feel that the time-consuming process of setting up procedure files for linking programs was an area for improvement.

CONCLUSIONS ...... After evaluating other TI systems, we feel the DS990 Model 4 continues the TI tradition of reliable, cost-effective equipment. An extensive line of OEMs does insure a wide offering of applications packages.

PROFILE: HP 250

Price as Tested = $30,350



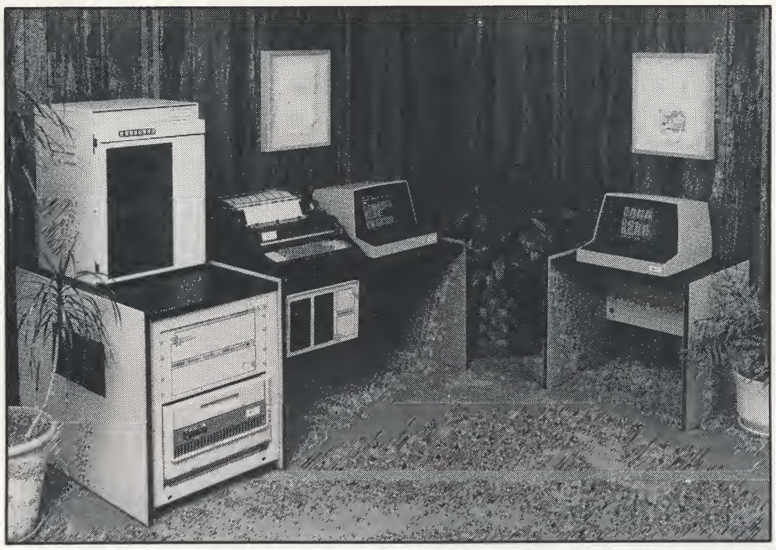
BEST FEATURES .... Without a doubt, the most impressive feature of the HP 250 is the special care that went into the human engineering features of the system. From a comfortable workstation to programmable "softkeys" to well-written documentation, the 250 is a friendly, "user-oriented" machine. A "BASIC language machine," the HP was characterized by the users we spoke to and by our own experiences as an "easy-to-program" system.

DRAWBACKS .... Users were extremely happy with their HP 250. There were some complaints received about response degradation when multiple terminals were used and some unhappiness with dealer support. We felt that one potential drawback might be in the limited number of terminals that can be added to the system.

CONCLUSIONS ...... Characterized as "extremely friendly" by the users we talked to, the HP 250 left us with the feeling that "here's a machine we'd like to program." Its combination of hardware dependability and "user-orientation" make the 250 a good choice for experienced and inexperienced users alike.

PROFILE: ALPHA MICRO AM-100T

Price as Tested = $35,680



BEST FEATURES .... System software and price were the two most oft-repeated reasons for purchasing the Alpha Micro according to the users in our survey. Through a combination of well-thought-out hardware and a powerful operating system, the Alpha Micro can grow with the user, without a lot of expense. We especially like the Alpha Micro full-screen editor (VUE) and other operating system utilities. A particular advantage of this system is that all utilities, editors, etc. will run from less-expensive non-intelligent terminals. This resulted in the AM showing the least cost for a full 8-terminal system.

DRAWBACKS .... Some operating system and utilities "bugs" were reported, though users were generally quick to point out that these were being corrected by Alpha Micro. The greatest area of dissatisfaction regarded the user/dealer interface. Some users expressed the feeling that more involvement with and concern for user problems on the part of Alpha Micro itself would go a long way toward relieving this problem.

CONCLUSIONS ...... With an entry level price that is reachable by many small businesses and system software that gives the Alpha Micro the power of a much larger machine, the Alpha Micro could be ideal for the small business computer user. The users we talked to would indicate, though, that special care must be exercised in choosing a competent AM vendor.

SUMMARY

In this report we have summarized the first six multi-user computer systems reviewed in our BENCHMARK REPORTS Series 3. Benchmark timings have been compared and the key features and limitations of each system extracted from each report. After reviewing the material contained here, the reader should return to the original reports for more detailed information and study.

In our opinion, each computer would perform adequately in many business applications, and each has certain characteristics which would make it ideal for specific applications. You, the user, must match the application and user requirements against system features before a choice can be made. For example, in a program development application we would prefer an interactive language, although this is less important than the availability of good debugging facilities. If we were buying a data base oriented application we would consider disk storage and backup capabilities important, but would tolerate some inconvenience there in order to deal with a reliable OEM who would provide good software support. Because we are dealing with multi-user computers with a variety of features and limitations, there are many such trade-offs which have to be made.

Unfortunately, our criteria and willingness to trade one capability for another are unrelated to yours, or your problems, or your needs. You should realize that many of our observations are from the programmer/system manager viewpoint, and are technical in nature. Yet we often find users who are extremely happy with their computer and the application programs who don't even know what model number of computer they are using, nor what peripheral equipment is attached. They bought a good application from a reliable supplier, and it works. That, in our opinion, is the critical factor for many businesses.

So, if you turned to this summary page expecting us to recommend any specific computer, you will be disappointed. They all get a check mark as good buys. The hard decision is not which computer system to buy, but deciding what criteria to use in making the choice. An analysis of user requirements is the first step in choosing a computing system. What we hope these reports have accomplished, beyond giving technical specifications, is to give you some insight into the criteria which you might want to use in evaluating alternatives.

BENCHMARK REPORT

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An association to help the computer user make informed decisions. . .

The Association of Computer Users is a world-wide professional organization devoted to providing an unbiased source of user oriented information on computers for business and scientific applications. It is organized as a nonprofit association to represent and serve computer users, and to provide a forum for the exchange of information about the many systems in use today.

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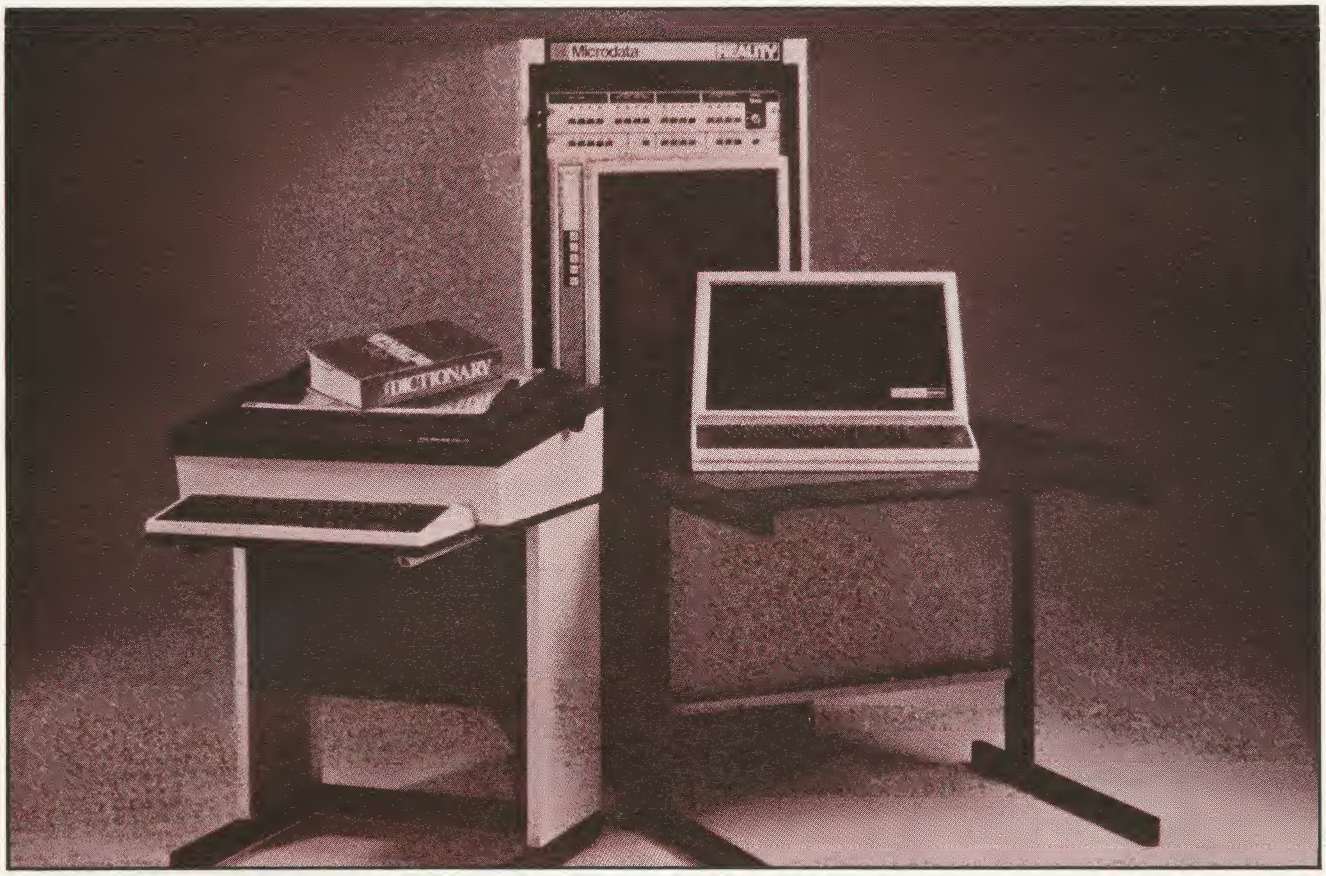

In This Issue:

The MICRODATA 4000

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MICRODATA 4000: BENCHMARK REPORT

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PREFACE

We begin the second half of our twelve reports on multi-user systems in the $25,000 to $50,000 price range with the Microdata Reality Series 4000. We must admit that we've been impressed with the capabilities of the minicomputer systems we've tested to date. Equally as impressive (at least to us), is the variety of ways each of these machines has solved our benchmark problems. From compiled languages to interpretive languages, shared code to multiple copies, we've seen six different ways to program our order-entry benchmark. Each approach has reflected that machine's unique features and capabilities.

One area of difference among systems which we've become particularly sensitive to is what we might call "overall ease of use" from the programming or application development perspective (the "Would you like to program this system" question). When performing our benchmark tests, we have found it necessary to become well acquainted with the way in which program development, system generation, and user/operating system interaction is handled by the system being tested. As a result, our "view" of the machine is often from a more technical and/or developmental aspect than that of many of our readers who may not actually program on the system they purchase, but who use turnkey packages instead.

Many of the problems we sometimes encounter and report on may never be seen by the user of a turnkey package. Since many of our readers may fall into this category, we have attempted to balance our more technical view with those of the users we contact in our users survey. Their comments provide our report with an "end-user" perspective.

With the Microdata 4000 in this report, and the five which follow, we look forward to seeing six additional differing sets of features and capabilities offered on systems in the $25,000 to $50,000 price range. It is our hope that the comparative information provided by these reports will aid the prospective user in selecting from the many alternative computing systems available--a service which is simply unavailable from any other independent source.

EXECUTIVE SUMMARY

The Microdata Reality Series 4000 used in our benchmark tests was configured with the Microdata 1600 CPU, 64 kilobytes of MOS main memory, a nine-track magnetic tape drive, a 30 megabyte hard disk drive, a 150 line-per-minute printer, a PRISM video display terminal, and nine total ports. Total price of the system as tested is $50,495 (a total of eight terminals would bring the price to $59,000).

- The Series 4000 performed extremely well in our order-entry benchmark. Its times were considerably faster than many of the systems we've tested to date. In the CPU-intensive test, quite the opposite happened as the 4000's times were a good deal slower than many of the other systems we've benchmarked.

- The Series 4000 is completely oriented towards database management processing. This orientation appears in every facet of the machine, from the programming and data retrieval languages to the very architecture of the CPU itself. The instruction set of the computer is optimized for character transfer and manipulation and this optimization is reflected in the benchmark timings we measured.

- The 4000 is a virtual machine. All of virtual memory (the disk) is addressable as if it were part of main memory. Through a technique called paging, the operating system reads in sections (or frames) of programs or files at a time which are then executed or operated upon. Thus, users need not limit program size to available main memory, but can program as if main memory were "virtually" unlimited. More efficient use of memory is obtained in this way and more users may have simultaneous access to the system.

- The Series 4000 can accommodate up to 32 users and up to 100 megabytes of hard disk. With a field upgrade to a Series 6000, main memory can be increased to 256 kilobytes and disk storage to 514 megabytes.

- Microdata offers the RESULTS series of business applications software. These "parameterized" programs, covering a full line of accounting, inventory, and sales functions, allow the user to do some customizing to modify the package for their business.

- The Series 4000 users we contacted in our survey were nearly unanimously satisfied with their system. ENGLISH, the Reality data retrieval language, was given special praise for its versatility and ease of use. Some complaints were registered though, about situations where the speed of the system was inadequate.

A very efficient database processing system, the Microdata Reality Series 4000 provides a flexible multi-user system capable of serving the information needs of a variety of businesses.

BENCHMARK REPORT

SYSTEM: Microdata 4000

PRICE AS TESTED $50,495

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-8	N = 3000	197.5 seconds
	I/O INTENSIVE	
B-4	N = 3000	40.3 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	1.6 seconds
D-2	4 terminals	1.7 seconds
D-3	6 terminals	1.9 seconds
D-4	8 terminals	2.5 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	2 terminals . .	204.4 seconds	1.8 seconds
E-2	4 terminals . .	212.1 seconds	2.0 seconds
E-3	6 terminals . .	223.5 seconds	2.4 seconds
E-4	8 terminals . .	239.7 seconds	3.4 seconds

Note: Order Entry Program times represent average processing time per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Microdata and requested their assistance in benchmarking the Series 4000. We requested that the total system be priced in the $25,000 to $50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 price limit, we advised Microdata that we would report the cost over-run, but would continue to benchmark the computer using up to eight terminals.

Microdata provided us with a Series 4000 at their offices in Newport Beach, California. The system consisted of the Microdata 1600 CPU, 64 kilobytes of main memory, a nine-track magnetic tape drive, a 30 megabyte hard disk, a 150 line-per-minute band printer, a PRISM CRT terminal, eight additional ports, and the system software which includes Microdata's DATA/BASIC and ENGLISH. Total system price as tested was $50,495. Microdata also provided programming and other on-site technical support during the benchmark tests.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the Series 4000) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-intensive and CPU-intensive program timings were made using a stopwatch (as in our Series 1 and Series 2 reports).

Benchmarking The Series 4000

A two day visit was required to benchmark the Series 4000. After correcting a minor hardware problem with our test equipment, communications between the Series 4000 and our RTE were easily established. Some time was then spent tracking down and solving some communication and configuration "bugs" with the assistance of Microdata personnel. The benchmark testing was then routinely completed the following day.

Our Observations

With each report we do in this series we are presented with a different approach to minicomputer hardware and software. The Microdata Reality Series 4000 is no exception with its database management processing orientation. This database orientation pervades every facet of the Series 4000, from its programming/retrieval languages to the architecture of the processor itself. The entire machine, from hardware through firmware to the software, is designed to optimize data retrieval and storage in a multi-user environment.

The Reality Series 4000 is a virtual memory machine (see pages 14 and 17 for an explanation of this technique). This approach requires a fast processor and efficient operating system due to the large amount of overhead required for the paging process. The 4000 uses microcoded firmware to accomplish this task. This firmware (software stored in a read-only memory or ROM) increases execution speed for the database orientation of the 4000 by allowing optimization of those machine instructions most necessary for this type of application (such as character moves, searches, and compares).

The Series 4000 employs a hierarchical file structure where files at one level point to multiple files at the next lower level. In our experience with the 4000, we found this organization took a little getting used to (primarily due to their own nomenclature which replaces the more common file-record-field terms), but with use, was easy to understand and employ.

A feature which Microdata is particularly proud of is their ENGLISH data retrieval language. This query language uses an "ENGLISH-like" syntax (noun, verb, modifiers) which can be easily learned by the non-computer-oriented business manager. Using ENGLISH, the manager can query the database for

information to be presented on his CRT screen (or a printer) in a variety of ways employing searches, sorts, etc., on any of a number of fields.

ENGLISH appears to be particularly useful for the manager when a non-standard, one-of-a-kind report would be necessary. For the more frequently or regularly requested reports, a PROC (stored procedure) can be set up so that only one simple command need be typed in to generate the report. We found the PROC processor to be useful, but overly difficult to implement. Many of the commands used in PROC are one or two character commands which may or may not bear any resemblance to the action initiated. Though extremely powerful (the user may be prompted for parameters, IF constructions are allowed, etc.), we feel the PROC processor could be designed to be more easily learned and used.

While ENGLISH provides the primary method of retrieving information from the database, DATA/BASIC programs are used to update and modify the data (the EDITOR can also be used, but it does not employ the data dictionary information). A compiled BASIC, a user may CATALOG a program, which makes the code "reentrant", enabling all users to share a single copy of the program in memory (this was the situation with our benchmark order-entry application). When combined with SCREENPRO, a software tool for designing, building, and processing of terminal display screens, powerful, compact code can be written for data input and updating. SCREENPRO also provides a facility for the creation of the data dictionaries.

The system is "booted-up" from the tape drive. During this process, the system configuration is determined by the system itself (it senses the number of communication lines, amount of main memory, and number, density, and size of the disk drives). By having the system essentially "configure itself" during the boot-up procedure, the user is freed from the often complex and time consuming "sysgen" procedures required on many other systems.

Communication with the 4000 system is accomplished through ENGLISH statements or Terminal Control Language (TCL). Using TCL, the user enters a "verb" (as in ENGLISH) which may invoke a processor (such as EDITOR or a DATA/BASIC program) or execute a system utility. So that a manager need not learn the 4000's vocabulary, these "verbs" may be customized for each user on the system by defining a synonym for the verb in that user's master dictionary.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying numbers of terminals
- An Order Entry program run with varying numbers of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide easy comparison with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	197.5 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	40.3 seconds

Comment: Since the Microdata supports only keyed record access, this program was rewritten to "simulate" sequential file processing (similar to our modification for Wang). Thus, this time is not directly comparable with other systems in this series.

"Real Life" Problems

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

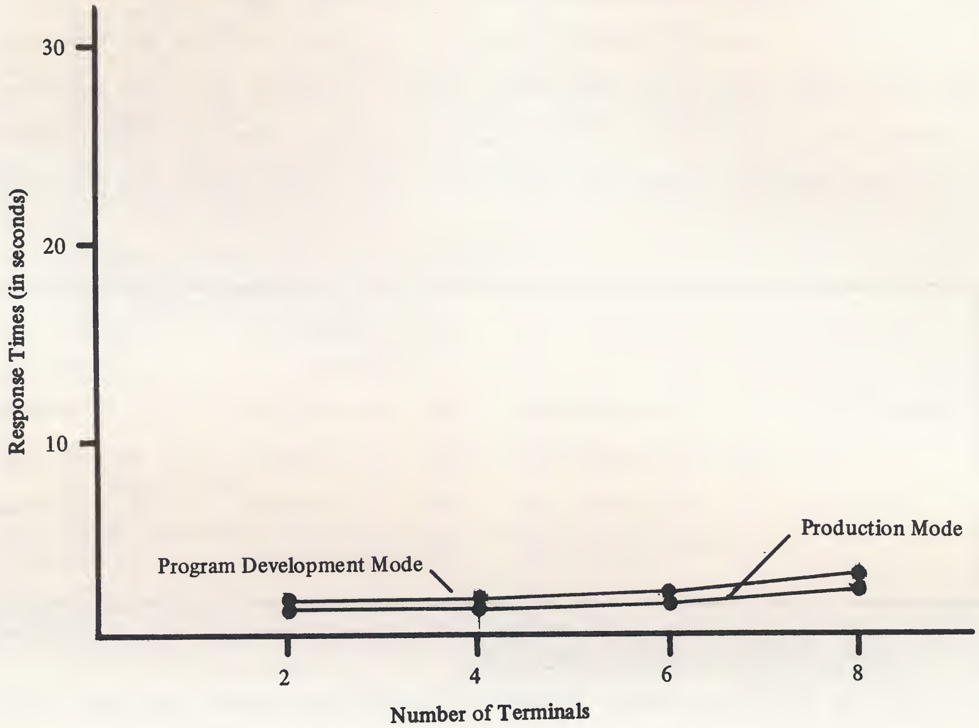
The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order Entry Run in Production Mode

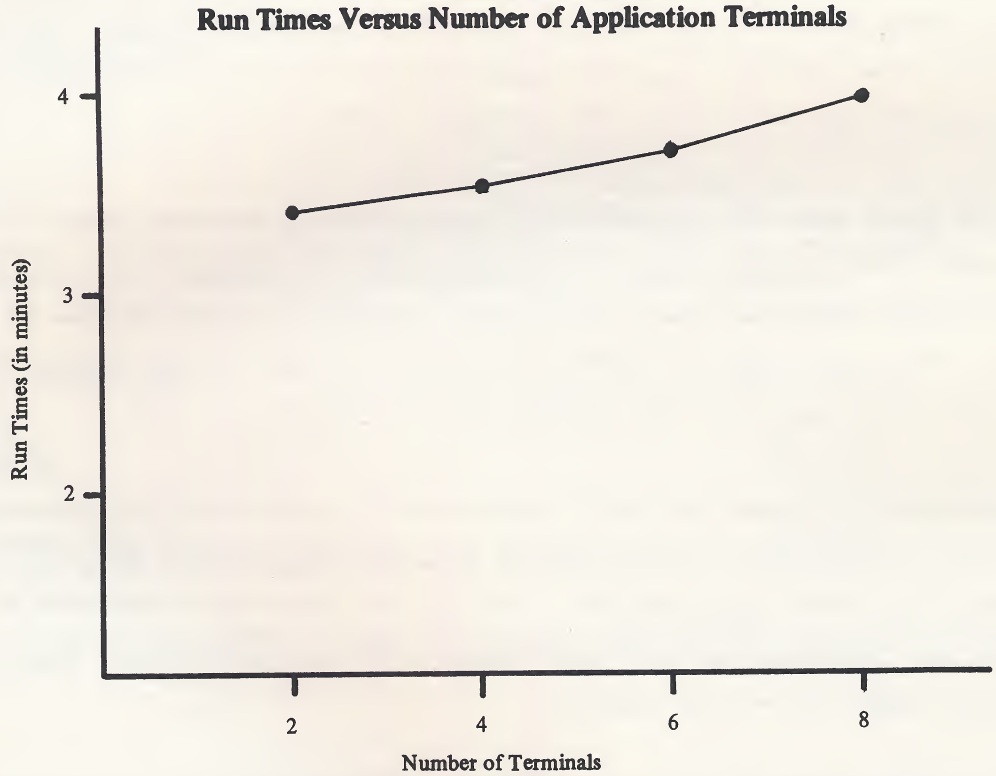
The order entry program was run with 2, 4, 6 and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	1.6 seconds
D-2		4 terminals	1.7 seconds
D-3		6 terminals	1.9 seconds
D-4		8 terminals	2.5 seconds

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order entry program running at the same time. Again, the measured times for the order entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order Entry Program
E-1	Results:	2 terminals	204.4 seconds	1.8 seconds
E-2		4 terminals	212.1 seconds	2.0 seconds
E-3		6 terminals	223.5 seconds	2.4 seconds
E-4		8 terminals	239.7 seconds	3.4 seconds

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order entry program for 2, 4, 6 and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-intensive job.

The first thing that one notices about these timings is that they are fast. The Series 4000 produced times on our order-entry benchmark that are from 20% to 400% faster than the other machines we've tested in this series of reports to date. The same cannot be said of the 4000's times on the CPU-intensive test, where the times are the slowest of all those we've seen.

This phenomenon reflects the multi-user database orientation of the Series 4000. Simply put, the machine is designed to optimize performance for interactive data entry/retrieval applications. And just as obviously, the 4000 is not intended for "number-crunching" applications where calculation, and not communication speed, is of the essence.

SYSTEM AS TESTED: MICRODATA 4000

Costs

Model R4510	
• Microdata 1600 CPU	$42,700
• 64 kilobytes MOS main memory	
• Magnetic tape drive (9 track, 45IPS, 800BPI)	
• REFLEX disk subsystem (30 megabytes)	
• 165 CPS matrix printer	
• PRISM video display terminal	
• One additional open port	
Seven additional ports	$ 4,795
• Seven OSFE (Operating System Functional Expansion) at $400 each	
• 5408 Asynchronous Communications Controller ($1,995)	
Substitute 150 line-per-minute printer for matrix printer	$ 3,000
Total System	$50,495

Our Observations

Prices for additional PRISM terminals are $2,500 for one terminal, $2,300 for two terminals, $2,100 for three terminals, and $1,900 for four or more terminals. After eight total terminals have been put on the system, the 5408 Asynchronous Communications Controller must be purchased before additional terminals may be added (up to eight more for each 5408). Prices below do not include the 150 LPM printer substitution.

Configuration	Total Price
System with one terminal	$42,700
System with two terminals	$45,200
System with four terminals	$49,000
System with six terminals	$52,200
System with eight terminals	$56,000

All prices given above include Microdata system software consisting of the operating system, ENGLISH, DATA/BASIC, PROC, SCREENPRO, EDITOR, and RUNOFF.

Summary of Equipment and Features

- The Microdata 1600 CPU is a microprogrammed processor whose microcode (the lowest level machine instructions that perform the actions indicated by an assembly level instruction) is contained in read-only memory or ROM (software stored in ROM is referred to as firmware). The instruction set of the CPU is optimized for character manipulation.

- Standard memory for the R4510 model is 64 kilobytes. Total main memory for the 4000 can be increased to 128K in two 32K increments ($2,950 each) or in a single 64K increment ($3,900).

- The 4000 can be upgraded to a Series 6000 (provides a maximum of 256K memory and 514 megabytes of disk) by adding an upgrade kit at a cost of $5,100 (memory must be at 128K). An upgrade to a Series 8000 (maximums increase to 512K memory, 514MB disk, and 48 ports) can be accomplished for $11,000 (plus $1,000 installation).

Our Observations

A virtual memory machine, while making efficient use of all available memory, does require a good deal of operating system overhead. Page faults, which occur when a program addresses a word which is not contained in central memory, can dramatically affect the performance of the system. As the number of page faults increase, the CPU spends more and more time waiting for disk I/O to be completed with the resultant effect of decreasing the response time of the system. Clearly, having adequate central memory available helps to alleviate this problem by allowing more pages for each job to be resident in memory. The very fast benchmark timings we obtained in this report are in part due to the fact that our application was not experiencing page faults. The copy of the program, which was shared by all active terminals, was in all likelihood entirely resident in memory throughout the benchmark test. Many of the users we talked to were not experiencing this "fault-free" environment and as a result were reporting situations in which they felt their system was slowing down quite noticeably.

User Comments

- *32K supports 7 simultaneous users adequately, if the applications are primarily data-entry. If ENGLISH is being used, or many different applications are being run, the system is too slow. I definitely need more memory than Microdata suggests.*
- *The operating system has a lot of very complicated things to do and this slows it down ... so you have to buy more memory. But it sure does a lot more than many of the other machines I've seen.*
- *It is slow on my invoice calculations ... sometimes I could do them faster in my head.*
- *Data-entry is very fast but calculations are a bit slow.*

STORAGE DEVICES

Summary of Equipment and Features

- Included in the Model R4510 is a magnetic tape drive (9 track, 45 inches per second, 800 bits per inch) and a 30 megabyte hard disk drive (up to two may be put on a system). At order time, a 1600 BPI tape drive may be substituted for an additional $1,500.
- The 30 megabyte drive may be increased to a total of 50 megabytes in 10 megabyte increments ($4,700 per 10MB). An additional 50 megabytes may be added by purchasing a second drive ($11,900).
- The 6000 and 8000 systems will support four rather than two disk drives providing total disk capacity of 200 megabytes (four Reflex I 50MB drives) or 514 megabytes (four Reflex II 128MB drives).

Our Observations

The tape drive provided with the Series 4000 gives the user an easy and efficient method of backing up disk storage. One feature we liked was the ability to get information from the backup procedure which analyzes the file allocations on disk and reports potential inefficiencies. At the user's option, the files can then be re-allocated during an "AF" restore (essentially a "warm-boot").

The hard disk/tape drive combination was very popular with the users contacted in our survey. High reliability was reported and users seemed especially pleased with ease of backing up large amounts of disk storage using the tape drive.

User Comments

- *Because of the variable length files, I'm able to pack a large amount of data on the disk ... and that's an important feature. I've saved an immense amount of storage, and with tape I can easily back-up the disk every night and take it out of the building.*
- *I back up my files every day with the tape ... I don't take chances.*
- *The tape drive is an integral part of the unit. It gives flexibility and security to the fixed disk.*
- *We anticipated using all of our 20 megabytes, but with variable length fields and automatic compressing of files, we've only used half of it.*

Summary of Equipment and Features

- The PRISM CRT employs the standard 24-by-80 screen using the 96 character ASCII set. It features switch selectable baud rates (50 to 9600 baud), direct cursor addressing, detached keyboard with separate numeric pad, and a serial printer interface to enable screen dump to a printer or straight-through copy of incoming data. Prices for the PRISM range from $2,500 for one terminal to $1,900 for four or more.

- To activate additional ports on-site costs $400 per port plus $350 for installation. After eight ports, the 5408 Asynchronous Communications Controller is required (it provides eight ports at a cost of $1,995).

- IBM emulation is available in two modes: The 5710 single line bisync controller and the 5750 Communications Terminal. The 5710 offers 2780 protocol and occupies one communications port ($4,450). The 5750 terminal offers emulation of IBM 2770, 2780, 3741, or 3780 protocols. The terminal concurrently supports communications protocols with remote mainframes while also responding to normal Reality interactive transactions. The number of communications terminals is only limited to the number of available terminal ports, allowing multiple simultaneous communication tasks ($8,100 each).

- The following substitutions can be made for the 165 CPS matrix printer at order time: 150 LPM printer ($3,000), 300 LPM printer ($6,000), and a 600 LPM printer ($10,700).

Our Observations

To permit simultaneous and independent access by many users of the system peripherals (printers, tape drive), SPOOLing is available (Simultaneous Peripheral Operation On Line). The Microdata spooler runs as a separate process and has its own communication line. Since a terminal for this line is not usually used, the spooler runs as a "phantom process." Up to 100 reports may be queued-up by the spooler awaiting output to the system printer. Users generally reported satisfaction with Microdata peripherals, with the exception of the 165 CPS matrix printer.

User Comments

- *The 150 LPM Printronix line printer is the hottest printer in the industry. Its print quality is unbelievable, it's compact, and was designed for minicomputers.*

- *The line printer is very good, but I don't like the matrix printer that much ... it's noisy and flimsy.*

- *The matrix printer is inferior ... they shouldn't sell it.*

- *The PRISM terminal is priced rather high, but it's a good terminal. I especially like the detached keyboard.*

OPERATING SYSTEM AND UTILITIES

Summary Of Features

- Included in the Series 4000 package is the virtual memory operating system and a variety of database management software including ENGLISH, DATA/BASIC, SCREENPRO, PROC, EDITOR, RUNOFF, an Assembly language, and various file maintenance and other utilities.
- Most Reality software is evoked directly from the Terminal Control Language (TCL) which provides the primary interface between the user and the various processors and utilities.

Our Observations

The Reality Series 4000 is a virtual memory machine. The 4000's virtual memory (which is disk) is directly addressable as if it were part of main memory. All data files, user and system programs, etc., are resident in virtual memory, while the operating monitor (the executive) is resident in main memory (it uses about 4K bytes). From the programmer or user standpoint, file size is "virtually" unlimited (limited only by the available space on the disk).

Each file or program is divided up into 512 byte frames or pages. Using a technique called paging, one frame at a time may be read into main memory and executed. When the program addresses a location which is not on the resident frame, the new frame is read (or "paged") into memory and execution is resumed. Each process (or terminal) requires a minimum of one frame in main memory to be actively executing (a user's program may be temporarily written out to disk or "swapped" if memory is required by other programs, but when the program is in main memory, it requires at least one frame). If memory is available, the system will allocate more to a user as needed and thus reduce the amount of paging needed to run the program.

The Series 4000 organizes files in a hierarchical structure so that files at one level point to multiple files at a lower level. The highest level file is the system dictionary. This dictionary (of which there is only one on a system) contains the list of valid users of the system, system utility and accounting files, and pointers to each user's master dictionary (the next level). The master dictionary for a user contains all file names and procedures accessible by that user and attributes which describe the structure of the information in the user's lower level dictionaries. Each master dictionary may point to a number of dictionary level files which describe the structure of the data in the associated data files. Each data file is described by one dictionary level file.

Within each data file there may be any number of records which can consist of one or more variable length fields. Each field in turn, may consist of any number of variable length values which may consist of any number of variable length subvalues. Records, fields, values, and subvalues are separated by special markers inserted by the system. The only size limit is a maximum record length of 32,267 bytes.

The data files may be accessed at the file-record-field level by the EDITOR and COPY processors. These processors (or utilities) do not distinguish among the fields as described in the data dictionaries, while the ENGLISH, SCREENPRO, and DATA/BASIC processors do use the data dictionaries. These dictionaries define the nature of the information stored in each of the fields and permit access by field name and specify internal and external data formats.

Communication with the Reality system is accomplished using Terminal Control Language (TCL). With TCL, the user may invoke utilities, processors, and programs by entering simple commands (called verbs). Any particular user may have an individualized vocabulary by defining synonyms for the system verbs. In addition, by entering or deleting verbs from a user's master dictionary, each user's capabilities on the system may be expanded or contracted without affecting any other users.

Through the use of the PROC processor, a user may store a complex sequence of operations which can later be invoked by a single word command. With features that include argument passing, terminal prompting, and branching, PROCs provide a useful and powerful tool for the user. Unfortunately, in our opinion, we felt the PROC "language" was overly complex as compared to similar features on other machines we've tested. We feel some simplification in this area would make this an even more useful tool.

The RUNOFF processor on the Reality system is a word processing utility that formats information through commands stored in the text to be processed. Features of RUNOFF include margin justification and automatic page numbering, chapter and section numbering, and table of contents and index generation.

System generation is an extremely simple process for the Series 4000 user. As opposed to many systems where the user must identify the hardware available to the software, the 4000 "senses" the available hardware and reports this to the user for verification. Thus, the "sysgen" process is automatically done by the system (and not the user) whenever a restore ("boot-up") is invoked. Whenever a complete restore is done (a power-up or "cold-boot"), the system will also rearrange the files to "clean up" wasted space (some user input is needed to accomplish this file "packing").

User Comments

- *PROC is exceptionally good. When combined with ENGLISH, it is the best thing Microdata has going for it.*
- *RUNOFF is impossible. The operator must go to the TCL, create a file, use the system editor, learn codes ... I don't want my secretaries running around in the computer.*
- *PROC is very useful to our programmer.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- The languages included with the Series 4000 are ENGLISH, a data retrieval/report generator language, and DATA/BASIC, an enhanced version of the standard Dartmouth BASIC.

- Microdata offers a set of applications programs called RESULTS. This package includes the following modules:

  - Payroll
  - General Ledger
  - Purchase Order Processing
  - Accounts Receivable
  - Order/Invoice Processing
  - Financial Reporting
  - Accounts Payable
  - Sales Analysis
  - Inventory Control

Our Observations

DATA/BASIC is a highly enhanced version of BASIC, and another of the versions we've seen that we think would be fun to program. DATA/BASIC combines some of the best features of BASIC (variable length string variables, multiple statements on a line, etc.) with many of the nicest features of FORTRAN (such as external subroutine calls, COMMON variable storage).

To retrieve data or generate reports, the 4000 user employs ENGLISH, the Reality data retrieval language. An easy-to-use language, ENGLISH statements are entered at the TCL level and consist of a relatively free-form sentence that begins with a verb indicating the action to be taken, the name of the file to be accessed, any qualifiers on the selection, and then the list of attributes which are to be printed on the report. ENGLISH uses the information in the user master dictionary to format the data and produce headings etc. Some of the actions that can be taken on the data include lists, sorts, counts or sums, and selections.

User Comments

- *I can't figure SCREENPRO out. It doesn't perform according to the documentation.*

- *ENGLISH is wonderful. I can train users in ten minutes. It's what makes this computer.*

- *ENGLISH cuts down on 75% of the programs I would need to write.*

- *DATA/BASIC is very easy to use ... I love it. Its only drawback is that when accuracy is required, it has some trouble with precision of numbers.*

- *I was lead to believe certain things from the RESULTS documentation that do not actually function.*

Summary of Features

- Through a network of approximately 70 service centers across the country, Microdata offers the following types of service:

  - Pre-Installation Site Planning. Assistance for the user to prepare the site prior to installation.
  - On-Site Installation. Requiring 3 or more days, Microdata personnel install the system and then perform acceptance tests before releasing the system to the user.
  - Contract Maintenance Service. Maintenance agreements are available with variable coverage.
  - Customer Training. Classes are offered on various aspects of the Reality system.

- A set of nine manuals are available for the Reality system. These manuals cover primarily the Reality programming languages and system operation.

- There are a couple of Microdata users groups in existence. These groups are independent and not directly supported by Microdata, though Microdata does provide experienced personnel to lecture when the groups conduct their annual meetings.

Our Observations

We found the Reality documentation to be well-written and helpful though they often tend to employ rather unique nomenclature. After gaining some experience with the system, the documentation can be seen to provide adequate information to use and program the system. As has been the case before though, many of the users we contacted do not completely agree with our assessment of the manuals.

User Comments

. *The documentation falls far short of the capabilities of the software.*

. *If the Microdata is lacking, they're lacking in manuals ... they're not very clear.*

. *I'm very satisfied with our hardware service, they're here within an hour.*

. *The documentation is adequate but the training was minimal. However, the ease of use of the system compensates for this.*

. *Everything Microdata has represented about the system has turned out to be true.*

SUMMARY OF USER COMMENTS

With names supplied by Microdata, we contacted twelve end-users of the Reality 4000. These firms included five wholesalers/retailers, a medical clinic, a city, a construction company, an ambulance company, and a professional sports team. These users, who had owned their system for 2 to 14 months, were generally running it a minimum of 8 hours a day, 5 days a week, with 3 to 12 different employees using the system.

The basic hardware configuration was 32K to 64K central memory, 10 to 30 megabytes of hard disk, 800 BPI tape drive, a variety of printers, and anywhere from 3 to 10 terminals. The users we surveyed reported that hardware dependability was very good and cited only very minor problems. On top of this, service was rated extremely high.

Most of the users we contacted were first time computer users, though some had used a service bureau previously. Many had evaluated a full range of minicomputers on the market and their reasons for choosing the Microdata included ENGLISH, ease of use, integrated data base management system, tape drive, report generating capability, and a sophisticated operating system.

The Microdata was being used for standard business applications such as: accounts receivable and payable, payroll, and heavy emphasis on financial reporting of all kinds. Most of the program development was being done by a third party, though two had Microdata's RESULTS package. Only one user reported a troublesome relationship with his third party programmer, and this definiately colored his feeling about the Microdata system. Several others felt that their programmers were having trouble understanding their particular application, but they were still satisfied with the progress of the software. One of the users of RESULTS said he was "led to believe certain things about it from the documentation that do not actually function" as stated.

Limitations of Microdata's documentation was a common thread that ran through comments about system capabilities and utilities. One user said "the documentation falls far short of the capabilities of the software." A comment that sums up how many users felt about documentation is, "If Microdata is lacking, they're lacking in manuals."

Contrary to our benchmark experience, the speed of the Microdata was often reported to be slow and was considered to be the main drawback of the system. Users noted that the speed depended on what was being done, but in general, a mix of different applications or calculation-intensive applications slowed it down. Many users agreed that more memory would speed it up, and the fact that the operating system used variable length records contributed to its slowness. But once again, users were happy with all of the other capabilities of the system and felt that speed was something they could "live with."

Of all of the Microdata's features, ENGLISH and PROC were viewed as the best of the system. Comments about SCREENPRO ranged from "it's good" to "it's difficult to use." Users said that it had bugs in it or that they were unable to use it fully due to limited documentation. RUNOFF was another utility about which there were mixed comments, with most reporting dissatisfaction. The majority liked the EDITOR, though none thought it was exceptional in any way.

The power of the system, according to the users were surveyed, came from the combination of PROC, ENGLISH, and DATA/BASIC. A comment about PROC was "it's excellent," though one user felt that it too had some bugs in it. The popularity of ENGLISH stemmed from its capability of making the system accessible to new users. One supervisor said he was "able to train users in 10 minutes to use the system." Another person said that ENGLISH "cut down by 75% the programs" he would otherwise need. DATA/BASIC was also a plus for the system because it was "easy to use" and "flexible." However, users noted some loss of flexibility because of "trouble with precision of numbers" and that Microdata "tried to do too much with it."

Of the twelve users we surveyed, eleven were either satisfied or totally ecstatic about their Microdata system. They feel it offers flexibility, a sophisticated operating system, and languages that serve experienced and inexperienced users alike. Though its slow speed was considered a drawback, this was not enough to dampen their enthusiasm for the system. When asked for their overall evaluation, some representative comments were: "I'd like it to be a little faster, even though it's doing incredible things for us" and "I wouldn't buy any other computer, I fully intend to stay with the Microdata."

CONCLUSIONS

The Microdata Reality Series 4000 reviewed in this report starts our second six reports in this series with an impressive performance. Its times on the order entry benchmark are the best we've reported to date.

In stark contrast to the order entry timings, the CPU-Intensive times for the Series 4000 were the slowest we've seen. This difference is explained by the database orientation of the 4000. Employing microcoded firmware which was designed to optimize character transfer and manipulation, the system performs very well in data-entry types of applications. This optimization was achieved at the expense of less than efficient computational capabilities.

The Series 4000 is the first virtual memory system we've tested in this series of reports and, we must say, we're impressed. Its sophisticated operating system offers features and capabilities more often seen on larger, more expensive systems (though it must be noted that the 4000 is one of the most expensive systems we have tested). With the capability of supporting up to 32 simultaneous users, the virtual memory system tends to efficiently use every available byte of main memory, though not without considerable overhead. For this reason, though memory is efficiently used, the prospective user must be sure to purchase adequate memory for the application(s) to be run, as the excessive paging required when insufficient memory is available can dramatically affect performance. This type of situation led a number of the users we surveyed to complain about the speed of the system while admitting that more memory would help to alleviate the problem.

Though many of the users we talked to viewed speed as a drawback of the Series 4000, this did not seem to dampen their overall enthusiasm for the system. ENGLISH, the data retrieval language, was cited for special praise by nearly every user we talked to. They felt ENGLISH was very easy to learn and easy to use. In addition, though several users felt the integral tape drive added considerable expense, they were nearly unanimously pleased with the backup capabilities it provided. The premier performer in our benchmark tests to date, the Microdata Reality Series 4000 offers many impressive capabilities. Though more expensive than many other systems, Series 4000 users feel, and we agree, that it offers capabilities that exceed its price.

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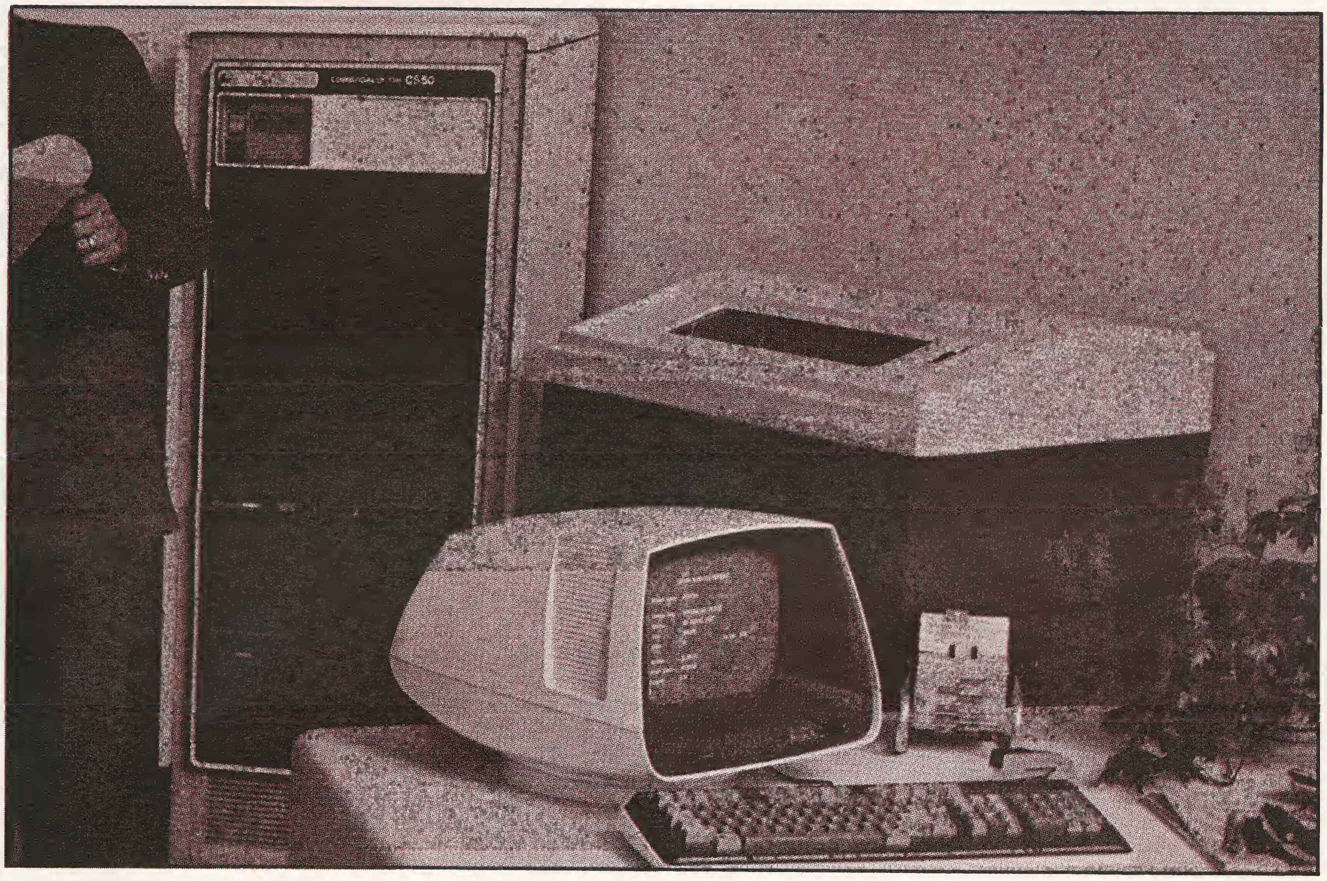

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The DATA GENERAL CS/50 Model C5

DATA GENERAL CS/50 MODEL C5: BENCHMARK REPORT

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PREFACE

In this, our eighth report on multi-user systems in the $25,000 to $50,000 price range, we review the Data General CS/50 Model C5 from DG's Commercial Systems Division. The purpose of these reports is to provide comparative information which will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source.

A variety of hardware and software approaches have been used by the various systems reviewed in this series. The technical specifications supplied by manufacturers often miss the real "essence" of a system--its ease of use and performance in a specific business application. Additionally, the technical information is often difficult to interpret and seldom comparable among alternative systems.

For these reports we have developed a "standard workload," a benchmark, which we can use to measure and compare performance among systems. Our standard consists of three computer programs which we run on each of the systems covered in this series. Two of the programs are identical to those found in the Series 1 and Series 2 reports, and provide comparability with the single-user systems under $25,000 covered in those reports. The third is a multi-terminal order-entry program specifically designed to measure degradation in response time as terminals are added to a system. The heart of this series of reports is the comparative results of running these three programs, in various combinations, on each of the systems under study. Differences in performance among systems can then be attributed to differences in computing capabilities.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating systems, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Data General CS/50 Model C5 used in our benchmark tests consisted of the Nova based processor, 256K bytes of central memory, a 20 megabyte disk cartridge unit (10 fixed/10 removable), a Dasher D2 console terminal, and the LP2 printer. The system was configured with the CS operating system and a COBOL language compiler. Total price of the system with no additional terminals is $44,185.

- Although the CS/50 was among the slowest of the systems we have tested to date, its average terminal response time with eight terminals running simultaneously would still be considered acceptable by most users.

- The programs were written in DG's version of COBOL which includes some structured programming statements, and a unique Screen Section in the Data Division. Screen can be laid out and referenced by the full screen, or by individual variables. Input and output formats can be controlled, edit checked, and forced as required or optional fields on data entry.

- COBOL is semi-compiled. The compiler produces an intermediate "pseudo" code which is transportable across the full CS line of computers. The "pseudo" code is executed by the run-time system.

- CS systems operate in three modes--utility, production, and concurrent. The utility mode is a single terminal system used for system maintenance utilities. The production mode is used for running and/or developing applications in COBOL. The concurrent mode causes one terminal to simulate a "batch" or utility mode, while other terminals remain in production mode. Certain system utilities, the compiler, and other activities can only be performed by the utility or concurrent terminal.

- Users were generally happy with the overall operation of the system. Throughput was acceptable, and reliability of equipment was not a problem. The only complaints, as usual, were with mechnical components like printers, keyboards, etc.

- One of the key features of the CS system is the compatibility of software and operating systems across the line, and the ease of upgrading the hardware configuration. This is a key factor for someone considering business expansion.

Overall, the performance of the CS/50 was quite acceptable, and it has some software features which would make it easy (and fun) to program. It was relatively easy to use, and the high degree of commonality across the CS line, along with expansion capabilities, make it quite attractive.

BENCHMARK REPORT

SYSTEM: DG CS/50 C5

PRICE AS TESTED: $44,185

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-8	N = 3000	56.3 seconds
	I/O INTENSIVE	
B-4	N = 3000	34.5 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	5.0 seconds
D-2	4 terminals	5.4 seconds
D-3	6 terminals	6.2 seconds
D-4	8 terminals	7.3 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	2 terminals . .	65.8 seconds	6.6 seconds
E-2	4 terminals . .	76.4 seconds	7.4 seconds
E-3	6 terminals . .	90.3 seconds	8.8 seconds
E-4	8 terminals . .	112.4 seconds	9.8 seconds

Note: Order Entry Program times represent average processing times per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

*Normally, A-4 (a program with square and square root) timings will be reported. The CS/50 does not have root functions in COBOL, so A-8 (using only multiplication and division) timings are given.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Data General and requested their assistance in benchmarking a multi-user version of their Commercial System line. The system was to be in the $25,000 to $50,000 price range, including as many terminals as possible up to a maximum of eight.

Data General provided us with a CS/50 Model C5 at their offices near Boston. The system consisted of a Nova processor, 256K bytes of memory, a Dasher D2 terminal with keyboard, a 20 megabyte hard disk (10 fixed and 10 removable), and an LP2 printer. The complete package is priced at $44,185 (with console terminal but exclusive of additional workstations). DG also provided us with programming and technical support for the benchmarking, including translating the benchmark programs to their version of COBOL.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time-measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, the North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the CS/50) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of one computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

Benchmarking the CS/50

One full day was required to benchmark the CS/50. We spent the first part of the day establishing communications and making program changes. The application program was corrected because of file handling and report generation errors, our driver program was modified to handle DG's automatic generation of the underline character for form fillout applications, some jumper wires

were prepared to interface our RS232 connectors with DG's standard circuit board plug, and an I/O board on the CS/50 was replaced. By mid-afternoon everything was working and we began the testing. No further problems were encountered and testing proceeded smoothly.

Our Observations

Data General's philosophy is to provide heavy support for the OEM who then develops and markets turnkey and custom packages. They are aiming for an end-user who is not interested in computers or programming, but only wants solutions to information management problems.

While many companies have this philosophy, DG has carried through by providing a number of software features which facilitate program development, thus allowing programmers to concentrate on the core of a problem and worry less about system management problems. Some of these features include Master Menu, Screen, and Proxi.

The Master Menu system provides system security and simplifies the creation of menus which an operator uses to gain access to application programs. First, it provides identification and password security. Then, each user can be presented a menu indicating what programs or applications they can run. This menu can be a tree structure where a selection from one menu will present a lower level menu. Eventually, the end nodes will be executable programs which perform some action. Users can be selectively locked out of certain programs or menu selections. In addition to these access rights, you can specify what terminal an individual may use, provide automatic time-out, and keep a security log of activity.

Screen is an editing utility which allows a programmer to create a picture of an input/output screen, and then automatically generate the COBOL code which will reproduce the screen during an application run. This greatly simplifies program coding since, in many cases, input/output displays are the most tedious programming chore.

Proxi is also a "program writer" which simplifies programming of core applications like file maintenance, inquiry, and report generation. Using

Proxi, the programmer specifies file and report layouts, and actions to be performed, and a nucleus COBOL program is automatically generated. These can be modified and combined into extensive application packages.

While these facilities may not be seen by the average user, they do indicate the extent of DG support of program development by the OEM, and imply that faster development, and more accurate or error free programs should result.

The CS/50's operating system is based on the traditional line-oriented system commands, an editor, a compiler, and an execution phase to program development. However, there are three modes of operation: utility, application, and concurrent. In the utility mode, only the master console is active. This is used for data base management utilities, the compiler, and communications control. In the application mode, the run-time system is active and all terminals can execute COBOL programs, as well as create new programs with the editors. The master console manages the run-time resources. In the concurrent mode, one terminal is designated the concurrent terminal and it performs in a utility mode. While other terminals can execute and create COBOL programs, only the concurrent terminal can compile programs and perform other utility functions. This terminal acts as a "batch" processor.

DG's version of COBOL has several nice features. It includes structured statements such as "IF ... THEN ... ELSE" and "PERFORM ... UNTIL." Additionally, they have implemented a Screen Section in COBOL's Data Division where an entire screen can be referenced. COBOL supports indexed, relative, or sequential file access, and several utilities are available for analyzing and structuring files for optimum performance.

Data General provides two levels of documentation. Manuals on equipment operation are oriented toward the unsophisticated user who must operate printers, terminals, or other peripherals. The second type of manual is for the experienced OEM and covers system generation, facilities, utilities, languages, etc. They are well done and include numerous examples. What might be missing are educational manuals for training unsophisticated users on system characteristics, programming, etc. However, given DG's orientation, they do not feel that their users want or need to know this information.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-intensive job
- An I/O-intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-8 | Results: N = 3000 56.3 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrives the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	34.5 seconds

"Real Life" Problems

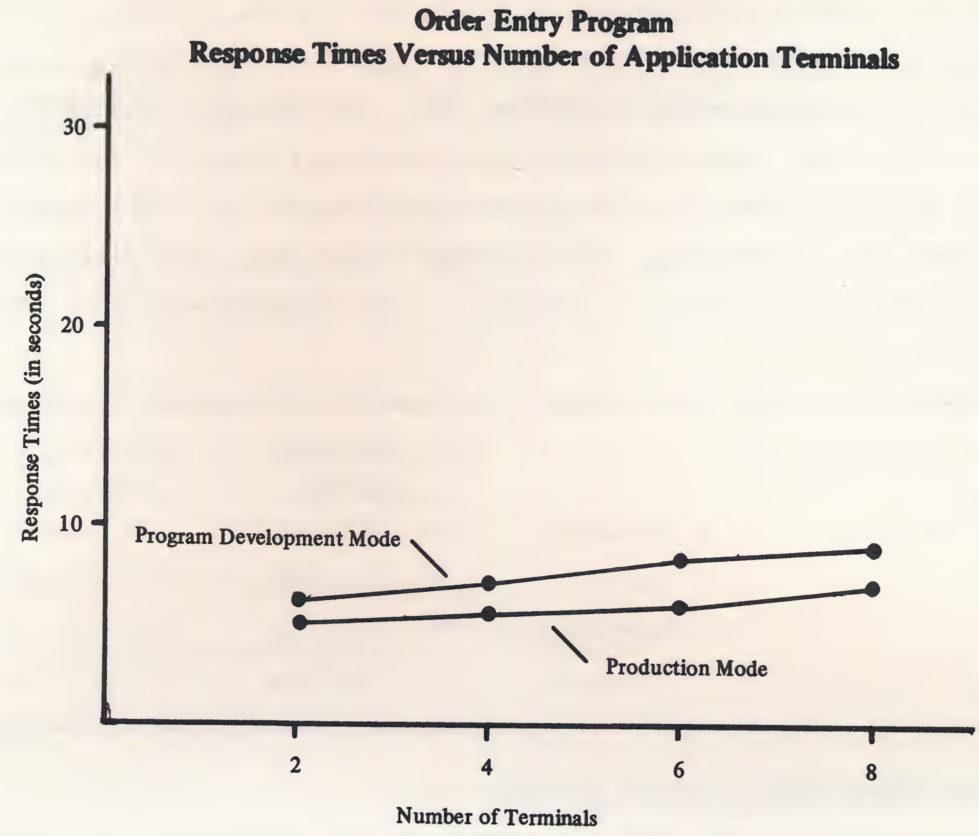
This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

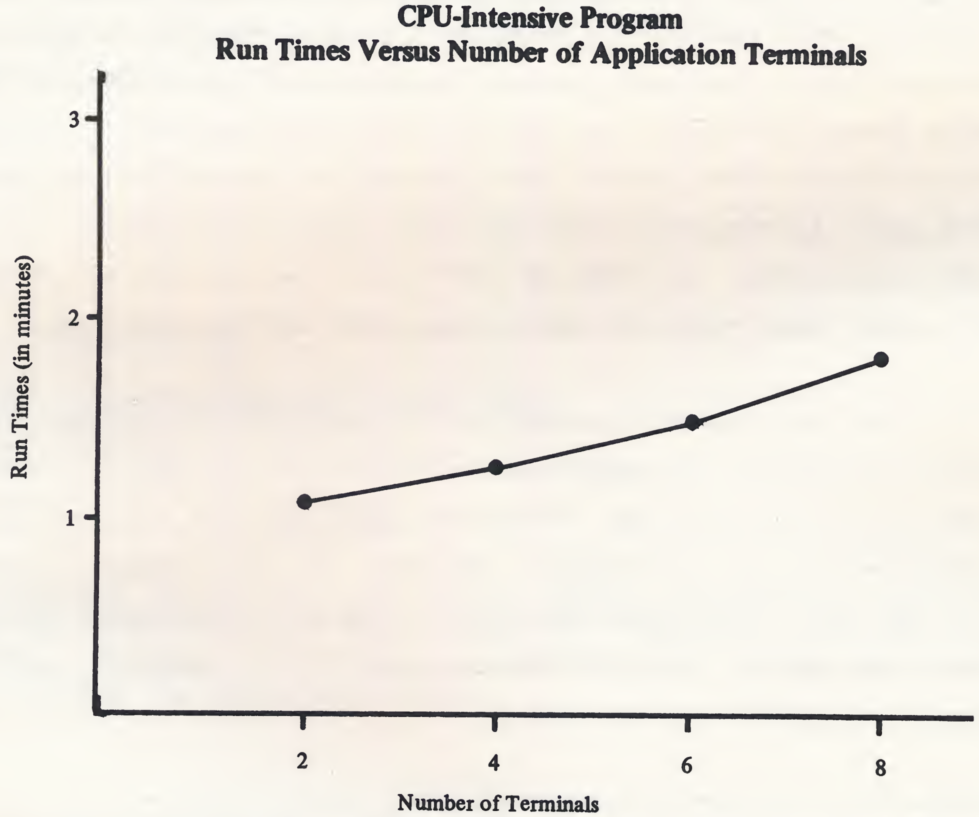
The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order-Entry Run in Production Mode

The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	5.0 seconds
D-2		4 terminals	5.4 seconds
D-3		6 terminals	6.2 seconds
D-4		8 terminals	7.3 seconds


Order Entry Program
Response Times Versus Number of Application Terminals
Response Times (in seconds)
30
20
10
Program Development Mode
Production Mode
2
4
6
8
Number of Terminals


CPU-Intensive Program
Run Times Versus Number of Application Terminals
Run Times (in minutes)
3
2
1
2
4
6
8
Number of Terminals

Order-Entry Run with Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	65.8 seconds	6.6 seconds
E-2		4 terminals	76.4 seconds	7.4 seconds
E-3		6 terminals	90.3 seconds	8.8 seconds
E-4		8 terminals	112.4 seconds	9.8 seconds

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real-life" problem. The first shows the time for the order-entry program for 2, 4, 6, and 8 terminals, both without the background program running (production mode) and with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times for the CPU-intensive job. NOTE: Our usage here of production and program development modes is consistent with our past usage of the terms to describe logical operating modes. In terms of DG's system definition, all programs were run in their multi-terminal application mode without concurrency.

The CS/50's times were relatively slow on the order-entry program. Adding the CPU-intensive program in the background caused a 30% degradation in response time on the order-entry program. Also, the move from 2 to 8 terminals caused nearly a 50% degradation in response. Finally, the CPU-intensive program doubled its run time going from stand-alone to 8 other terminals running. Nonetheless, its average terminal response time with 8 terminals would still be considered acceptable by most users.

SYSTEM AS TESTED: DATA GENERAL CS/50 MODEL C5

Costs

The configuration we tested included a standard package of options (feature number 9231-N), plus a system console, printer, and port expansion unit.

CS/50 Model C5	$44,185

- Nova processor with 256K bytes of memory
- 20 megabyte disk cartridge (10 fixed/10 removable)
- Terminal connection unit (4 terminals, console, line printer)
- License to use COBOL
- Six 10 megabyte cartridges

A second terminal connector unit	1,400
Dasher D2 Display Terminal	2,650
Dasher LP2 Printer System	4,550
Total System	$44,185

Our Observations

Additional terminals could be chosen from among the D2 (at $2,650), the D3 (at $2,890) or the D200 (at $1,950). Beyond 4 terminals (plus console) an additional terminal connector unit is required. We have priced the following configurations with the D2 as the first terminal and the D200 for additional terminals.

Configuration	
Single-user system (D2 console only)	$42,785
System with two terminals	44,735
System with four terminals	48,635
System with six terminals	53,935
System with eight terminals	57,835

As with all our pricing information, cables, connectors, installation, etc., may add to the price. Additionally, site preparation charges are not included. Finally, price changes sometimes occur between our benchmark report preparation and final publication.

Summary of Equipment and Features

- The CS/50 is based on the widely used Nova 16-bit processor system. The basic unit comes housed in a single bay cabinet with disk drive and 128K bytes of memory.
- The unit can be upgraded to 256K of memory and 190 megabytes of disk storage. It is also possible to upgrade to the CS/60 Eclipse processor which can include up to 512K bytes of error checking/correcting memory.
- The system can be generated as a memory mapped or a disk-swapping configuration. We used the memory mapped version where each program is allocated a memory partition in which the entire program is loaded, and a maximum number of programs can occupy memory.

Our Observations

The CS/50 is one of a series of commercial systems from Data General that run from the MicroNova based CS/10 through the Eclipse based CS/70. They have been designed for compatibility of software so that programs developed on one system can be run on larger systems, thus facilitating upgrades within the line.

With the many programming aids available, we would feel comfortable developing applications on the DG systems (see page 17 for more details).

Because detailed system manuals are not available, we cannot describe the hardware configuration, system memory requirements and memory allocation schemes, or the allocation of time slices to terminals.

The CS/50's performance was relatively weak. Times on the CPU-intensive job were among the longest, though the I/O-intensive run time was in the middle of the systems we've tested.

User Comments

. *Overall I'm satisfied with the system, though it is rather slow.*

. *Speed is excellent. Response time with multi-users is surprisingly fast.*

. *Only been down once in three months (for three days).*

. *We have had only minor problems that have been fixed in a day.*

STORAGE DEVICES

Summary of Equipment and Features

- The basic unit comes with a 20 megabyte cartridge disk subsystem (10 megabytes fixed and 10 megabytes removable) mounted in the single bay cabinet.

- Other options on the basic unit include

  - a 12.5 megabyte fixed disk with 1.2 megabyte diskette
  - a 25 megabyte fixed disk with 1.2 megabyte diskette
  - a 25 megabyte fixed disk with 800 bpi magnetic tape drive
  - a 25 megabyte fixed disk with 800/1600 bpi magnetic tape drive

  These can generally be purchased as add-on items to a basic unit, and you can purchase 50, 96, and 190 megabyte disk units (on the Model C6).

- A maximum of 80 megabytes of storage on the Model C5 and 760 megabytes on the Model C6, along with a tape unit for backup and transfer of files, provides sufficient storage and expansion capabilities for many businesses.

Our Observations

Expansion and upgrading within the CS line is relatively easy. The Model C5 can be changed to a Model C6 (50 megabyte disk or higher with tape drive), or the CS/60 (Eclipse based system).

A directory is maintained on each device indicating the location of program and data files. File names in a COBOL program are internal names, and they can be linked to physical files at run time.

The standard assortment of file management utilities is available. These include the COPY and SORT/MERGE utilities, as well as the ability to reorganize file structures (REORG), compaction of files to physically eliminate deleted records (COLLAPSE). Three other utilities are useful in designing applications: FILESTATS to help predict optimum file organization, INQUIRE for creating test data files, and ANALYZE for monitoring file activity.

User Comments

- *I've had lots of problems with the disk and DG hasn't been responsive.*
- *Fifty megabytes of storage is plenty for us at this moment.*

Summary of Equipment and Features

- The terminals which are used with the CS systems include the Dasher D2, the D3, and the D200. The principal difference is in the keyboard layout. All terminals include a CRT and a detached keyboard.
- Terminals can have an attached printer which can be used to produce hard copies of information sent to the CRT screen. The Dasher D3 has an expanded buffer which can print up to 132 characters on the printer without affecting the screen display.
- A variety of printers are available, ranging from a 55 cps letter quality printer, to the 180 cps LP2 character oriented printers, and through a range of 230 to 900 line-per-minute line printers. The higher speed printers must be used with a special interface on the terminal connection unit (TCU) though slower printers can be attached via a standard terminal port.
- The Dasher D4/D5 combination provides remote access, via telephone lines, and allows a remote D5 terminal to act in parallel with a D4 locally attached as the system console.

Our Observations

The ability to attach a printer to any Dasher terminal facilitates program development from remote locations. Users do not have to go to the computer room to pick up output but can print, as needed, anything appearing on the CRT. Thus, users can be dispersed throughout a building and still have hard copy immediately available.

The Dasher D4/D5 terminals are generally used for remote diagnostic work by hardware and software personnel. If the user is having problems with an application, he can contact the OEM who can check out the programs and/or can watch the user interaction with the program (via the remote D5 connected to the local D4). This means that an OEM can service customers quickly because he does not have to travel to the site. This same feature can be used by hardware personnel to run remote diagnostics in case of hardware malfunctions.

User Comments

- *The D200 has a poor quality keyboard ... the keys keep popping off.*
- *The 300 lpm printer is fantastic.*
- *The LP2 (180 cps) printer is too slow. They shouldn't even supply it with this system.*

Summary of Features

- Data General has developed an operating system and utilities which are compatible across the entire Commercial Systems line (CS/10 through CS/70).

- The components of the CS systems include:

  - The operating system with its command language
  - Utilities for system management
  - Editors and other program preparation utilities
  - The COBOL language and compiler
  - File maintenance utilities

- There are three modes of operation: utility, application, and concurrent. The utility mode is used principally for system maintenance functions. Application mode would be found in a typical user environment where only applications are being run. Concurrency would be found where program development was taking place.

Our Observations

The Commercial Systems line is oriented to rapid program development and software compatibility across the line. The hardware and system software are a packaged subset of the hardware and software sold by other DG divisions. By packaging as units, the price can be kept lower, servicing is much easier, and system software development is restricted to a few major pieces of hardware.

The operating system environment is unique on the CS line. On most computer systems, the full range of system capabilities is available to each terminal user (except for system resource management which may have to be done at a designated console). This is what we could call the purely interactive mode where each user behaves as if he was the only individual using the system.

The CS line, on the other hand, has three distinctly different operating modes. In the utility mode, only the system console is active, and it has access to all features of the system. There are some system maintenance utilities which can only be run in this mode of operation.

In the application mode, all terminals are active. The system console manages system resources such as scheduling the printer queue, activating and deactivating other terminals, running the interactive COBOL debugger, etc. All terminals can execute COBOL programs, and can edit new programs (though they cannot be compiled).

In the concurrent mode, a separate terminal acts as a "pseudo batch" processor which can execute in the utility mode while the remaining

terminals continue to operate in the application mode. Thus, programs to be compiled, and other requests for system action and utilities, must be "submitted" to this concurrent terminal which queues up user requests and executes them in sequence (much like what occurs on many time-sharing systems).

System software includes:

- MASTER MENU - This system can be used to create menus, personalized for each operator and/or application system, which allow the user to select the activity, program, or application to be executed. A password and identification system is used, users can be selectively locked out of running certain programs, and a security log is maintained on the system. It is very easy to set up this menu system.
- CLI - The Command Line Interpreter executes system commands. These include file handling commands, directory commands, system management commands, and system information commands.
- Utilities - Utilities are typically just expanded system commands that invoke a complex sequence of actions. The CS utility programs mostly involve routine file maintenance procedures, though system generation and other miscellaneous utilities are included.
- LJE - Local Job Entry is a special utility which allows a user to create and "submit" a sequence of commands. In systems without concurrency, these "jobs" are queued up and run at the end of the day (or whenever the system is dropped from production mode and put into utility mode). On systems with concurrency, these "jobs" may be run immediately by the concurrent terminal, or may be queued to run at the end of the day.
- RJE - The communications utility allows the system to emulate IBM 2780/3780 terminals and HASP workstations using bisync communications.

User Comments

. *We like everything about the system.*

. *It's a very forgiving machine. Not hard to run at all.*

LANGUAGES AND APPLICATION PACKAGES

Summary of Features

- COBOL is the only programming language available on the CS systems. It includes some structured programming statements, and a unique Screen Section in the Data Division which simplifies writing screen-oriented input/output applications. COBOL supports sequential, indexed, and relative file structures.
- A series of program development tools are available which facilitate writing business applications. These include:
  - SCREEN - An editor which allows a programmer to paint a screen, including prompts and input/output fields. The editor then generates the COBOL code associated with the screen which can then be included in the application program.
  - IC/EDIT - An interactive editor designed for writing COBOL code.
  - PROXI - An interactive "program writer" which generates COBOL code. The programmer defines data structures and procedures, principally file maintenance activities and report formats, and PROXI generates core code modules which can be combined into a complete program.
  - DEBUG - An interactive debugging facility which greatly simplifies program development. You can run sections of any program, set breakpoints for automatic halts, display and set variable values, and step one paragraph at a time.

Our Observations

COBOL is semi-compiled, where the compiler produces an intermediate "pseudo" code which is later executed by the run-time system. It is this feature which produces the upward compatibility of programs since all compilers produce the same intermediate code, and only the run-time systems vary across machines.

The program development features are very useful, both for OEM's and final users who plan to write some applications in-house. Because applications can be written faster, and accurate code generated, the cost of program development should be relatively low.

DG does not support end-user application packages, though they do provide some core packages in accounting for customization by OEM's.

User Comments

- *COBOL is excellent. Very easy to use for file access.*
- *COBOL is tops.*
- *IC/EDIT is frustrating. It's the only thing I don't like about the system.*

Summary of Features

- Data General provides maintenance contracts for hardware. Self-maintenance and third-party contracts are also possibilities.
- The system documentation, including COBOL and program development features, is provided by Data General. Software documentation is the responsibility of the OEM.
- Training on system use is the responsibility of the OEM, and would generally be included in the application system price.

Our Observations

While third-party maintenance is a possibility, we would recommend a contract with DG. They would have the inventory of parts, well trained personnel, and a good working knowledge of the system.

For software maintenance, you will be dependent upon the OEM. As always, user dissatisfaction with the CS system was often a direct function of their satisfaction with the OEM.

It is wise to always purchase a software maintenance contract with the OEM if one is offered. Additionally, the OEM may suggest you purchase or lease a Dasher D4 terminal for remote diagnostic and maintenance service. While you may not think it is worth the additional cost (as one user of a CS/10 system commented), we would think such a service would be well worth the cost, particularly during the first few months of operating a new system and/or application.

DG's documentation was very good. The COBOL manual included many examples, as did the utility manuals. Technical information was sparse, but most users would not be interested in that. Equipment operation manuals for the user were particularly well done, and included many illustrations covering daily maintenance of equipment.

User Comments

- *Servicing is better now than it has been in the past.*
- *We have had excellent hardware service.*
- *Documentation is fine, though it's sometimes more involved that we need.*
- *Good documentation, other than the COBOL manual which assumes you know a lot more than you do. Operating level instructions are very good. DG is end-user oriented.*

SUMMARY OF USER COMMENTS

Using names supplied by Data General and the Association of Computer Users, we contacted seven end-users of the DG CS/50. Two firms had the Model C5, others had the C3 and C6, or did not know which model they had. Two of the firms were manufacturers, others included a wholesaler, a hotel and motel management firm, and a general contractor. These users were using the CS/50 for standard business applications: accounts payable, receivable, payroll, general ledger and inventory control. No one had the system more than six months, and most had had it only three months. Over half the users reported using it from 12 to 17 hours a day, six days a week. Others used the system 40 hours a week.

Hardware configurations tended to be unique across users. Central memory ranged from 64K to 256K. Two users had 1.2MB floppy disk drives along with 12.5MB hard disk, and others had 20 to 100 megabytes of hard disk storage. Three users had the 180 cps LP2 printer while others had the 300 lpm or 600 lpm printers. Everyone was using the D200 terminals (with up to four maximum).

Some firms had previously used such systems as IBM, Honeywell, Burroughs B700, and DEC while for others the CS/50 was their first computer. A variety of reasons were given for buying the DG including price, software, multi-user capability, proximity of field offices, and cost of peripherals. Users had considered IBM, Wang, TI, Honeywell, HP, Digital and Datapoint when shopping for their system.

CS/50 hardware reliability was not the same for all users. The majority, however, felt the problems were only minor or typical. One very dissatisfied user has had persistent troubles with his system. He classified his problems as "eternal," and said he'd had 27 service visits in six months. However, another user with many startup problems was satisfied with his CS/50 and Data General's support.

Users with the LP2 printer felt it was much too slow for their system, awkward to handle, and felt that DG should not allow these printers to be purchased with a CS/50. Comments about the D200 included users who would have preferred

a green rather than white screen, and having it slanted or shaded. Some said the keyboard was of poor quality (the keys popped off) and others did not like the location of some of the keys. However, equipment operating reliability was good.

In all cases, users bought programs from a third party and all but one user depended upon outside help for program modification. Half the users used CRT/EDIT and liked it or said it was "excellent." Another person used IC/EDIT and said it "was frustrating to use because of its command structure and line orientation." These users were completely happy with DG's COBOL programming language. Two users pointed out that one of its best features was the easy file access methods. Another felt a novice programmer could quickly program the system because of the simplicity of the COBOL command structure.

System documentation was viewed as needing improvement and too technical, explaining "one technical term with another technical term." Others thought it was "weighty" and another said DG had "good documentation except for the COBOL manual; the operating level instructions are well documented."

The CS/50 operating system was perhaps the best feature of the system for most users. Users were divided, however, on their feelings about its speed. a remark that sums up its speed for some is, "Speed depends on how many people are using it. With one person it's great, depends on the program too." All in all, these users were pleased with the operating system and were not too hampered by its speed.

Although we only contacted seven users, results revealed a range of experiences and feelings about the CS/50. Hardware was reliable for all but two of the users, and except for them, DG hardware service was felt to be good. Peripherals presented some inconveniences. Documentation seemed to provide enough answers but at a technical level too far above most users. DG's COBOL was one of the better features of the system. And except for variations in speed, the users were satisfied with the operating system and felt it was any easy system to use. Finally, asked for an overall evaluation of their system, the users' responses were generally positive.

CONCLUSIONS

The Data General CS/50 Model C5 reviewed in this report is one of a series of Commercial Systems models ranging from the MicroNova based CS/10 through the Eclipse based CS/70 and all using the COBOL language. Starting with a small system, a user could gradually expand to a very large capacity machine, using the same software throughout the process.

Data General is very much oriented toward the program developer, particularly the OEM who develops applications software and markets turnkey systems. Several tools for program development are provided with the system. These include some program generators which produce core COBOL modules for inclusion in larger business application programs.

The CS/50's performance on our benchmark programs placed it as one of the slower machines tested on the order-entry application. There was a noticeable degradation in response times as more terminals were added and when we ran the CPU-intensive program in the background. Nonetheless, its average terminal response times would still be considered acceptable by most users.

The CS operating system is unique among those we have studied. With its three modes of operation--utility, production, and concurrent--the user may occasionally be restricted in what can be accomplished at any point in time. Multi-terminal operation with program development requires concurrency, where the concurrent terminal appears as a remote batch system which executes the compiler, performs utility functions, etc.

User reaction to hardware, software, and system performance was mixed. The most negative hardware comments dealt with the Dasher D200 terminal, and the slow speed of the LP2 printer. Documentation was generally perceived as well done, as was hardware service support from DG. Although the system was not seen as particularly fast, most users were satisfied with throughput and performance.

Overall, the Data General CS/50 was a relatively easy machine to work with, and it had a very straightforward approach to system commands. Its key feature, particularly for those considering expansion, is the compatibility of operating system and application software through the Commercial System line, and the ease of hardware upgrades.

BENCHMARK REPORT

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The Association of Computer Users is a world-wide professional organization devoted to providing an unbiased source of user oriented information on computers for business and scientific applications. It is organized as a nonprofit association to represent and serve computer users, and to provide a forum for the exchange of information about the many systems in use today.

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In This Issue:

The BURROUGHS B91

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BURROUGHS B91: BENCHMARK REPORT

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PREFACE

Our ninth report in this series on multi-user systems in the $25,000 to $50,000 price range is on the Burroughs B91. Our purpose in these reports is to provide comparative information which will aid users in selecting from among the many alternative computing systems now available--a service which is simply unavailable from any other independent source.

In evaluating computing systems, the technical specifications supplied by manufacturers are often difficult to interpret and are seldom comparable across different computers. The potential buyer needs to know how well the equipment performs in specific applications, and how that performance compares with other computing systems. Additionally, many important less quantifiable factors such as ease of use, versatility, and support services must be considered in the selection process.

Measurement of performance is a difficult task since there are no generally accepted measures of "amount of work" that can be performed by a computing system. What we must do is define a "standard workload", or benchmark, and measure how well various systems perform this standardized task. We employ a set of three benchmark programs designed to test different aspects of a computing system. One of the benchmarks is a multi-terminal order entry system designed by our staff to measure degradation in response time as terminals or background jobs are added to the system. To measure the response time, we have developed a Remote Terminal Emulator (RTE) which emulates users sitting at terminals entering data and measures the time needed by the test system to respond.

Although the Burroughs B91 uses a unique communications system which could not be efficiently interfaced to our RTE, our preliminary discussions with Burroughs personnel revealed that they had devised an RTE and benchmarking technique very similar to the one used in this series of reports. Due to this technical similarity, and a desire to present our readers with the wide variety of computing systems available in this price range, ACU agreed to observe the Burroughs benchmark process and report the findings in this BENCHMARK REPORT.

EXECUTIVE SUMMARY

The Burroughs B91 examined in this report consisted of the B91 with 256 kilobytes of central memory, a built-in 90 character-per-second printer, a 1 megabyte floppy disk drive, a 9.4 megabyte fixed disk drive, a 160 line-per-minute printer, a data communications control, and a MT983 Modular Terminal System. Total price for this configuration, excluding software, was $28,562 (the system with eight terminals would cost $49,359).

- The B91 is one in a family of Burroughs CMS (Computer Management Systems) computers which also includes the B92, B93, B920, and the B1900. Application software can be moved among the CMS family without requiring modification or recompilation.

- Burroughs offers an extensive line of application software covering general business accounting, production control, hospital and bank management, governmental accounting, and more. Twelve of the fourteen users we surveyed were using Burroughs packages, and indicated to us their pleasure with the packages' performance.

- Burroughs has developed an extremely high capacity floppy disk system for use on the B91 called the Super Mini-Disk II. With a capacity of 3 megabytes per eight inch disk, the BSMD II provides three times the usual industry maximum.

- The users we contacted in our survey were generally quite pleased with their B91 system. They often cited Burroughs' service, training, and support for special praise.

- Unfortunately, Burroughs indicated to us that the B91 could not be properly interfaced with our Remote Terminal Emulator. When further discussions with Burroughs personnel revealed a Burroughs RTE and benchmarking technique very similar to our own, ACU agreed to have us observe the Burroughs benchmark process. For this reason, the "Real-Life" problem times in this report are not directly comparable with the other timings in this series of reports. Nonetheless, it appears that the B91's timings are roughly in the middle of the other timings we've observed in this series of reports.

The Burroughs B91 offers state-of-the-art hardware and impressive data communications capabilities. When combined with Burroughs' application software and support, the B91 users we surveyed were confident they had chosen the right system for their needs.

BENCHMARK REPORT

SYSTEM: Burroughs B91

PRICE AS TESTED: $28,562

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-4	N = 3000	8.0 seconds*
	I/O INTENSIVE	
B-4	N = 3000	14.7 seconds

"REAL LIFE" PROBLEMS

NOTE: The order entry program times for this report were measured by Burroughs' own RTE. For this reason, they are not directly comparable with the times reported on the other systems we've tested. See the Analysis of "Real Life" Problem Results Section for further explanation.

*Normally, A-4 (a program with square and square root) timings will be reported. The B91 does not have root functions in COBOL, so A-8 (using only multiplication and division) timings are given.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Burroughs and requested their assistance in benchmarking the B91. We requested that the total system be priced in the $25,000 to $50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 price limit, we advised Burroughs that we would report the cost overrun, but would continue to benchmark the computer using up to eight terminals.

During our preliminary technical discussions with Burroughs, it became clear that because of the B91's unique communication techniques, our Remote Terminal Emulator could not be used to test the B91. Though the B91 can handle well beyond the eight terminals in our benchmark order entry test, only two asynchronous RS-232C ports are available in their multidropped configuration (our RTE requires an individual port for each terminal to be run, while a multidrop line will handle multiple terminals at each port).

As discussions continued, we found that Burroughs own internal benchmarking procedures were very similar to our own. In fact, the primary differences involved only the technical implementation of the RTE, not what their procedures were designed to accomplish or measure. The technical similarity of our own and Burroughs' procedures combined with a desire to present our readers with reports covering popular, well-known systems in the $25,000 to $50,000 price range led ACU to agree to have our benchmark team observe the Burrough's benchmark procedure and report our findings here.

Burroughs provided us with a B91 system and their benchmark team at their plant in Cumbernauld, Scotland. The system consisted of the B91 with 256 kilobytes of main memory, a built-in 90 cps printer, a one megabyte floppy disk drive, a 9.4 megabyte fixed disk drive, a 160 lpm printer, a data communications control, and a MT983 Modular Terminal System. System price without software was $28,562 (an eight terminal configuration would be $49,359). The B91 Master Control Program and utilities cost $3,040. Compilers and other software developmental aids are additional.

Benchmarking the B91

During a two-day visit, we observed the Burroughs benchmark team and system as they ran our benchmark test programs. Their procedure also uses a Remote Terminal Emulator to emulate users sitting at terminals and to record the response times of the host system. As in our other reports, we used a stopwatch to time the single-user CPU-Intensive and I/O-Intensive test programs.

The Burroughs RTE is a B91 computer and the appropriate software. This system monitors communications on the multidrop line and can transmit messages up and down the line, making it appear to the test computer as if a message was coming from a specific terminal.

In their normal mode of operation, when first setting up a benchmark test, the Burroughs benchmark team will place a number of terminals on the line and have human operators actually participate in the test. As the operators interact with the test computer, the RTE monitors the communications line and records the traffic on the line (the information itself and the rate at which the operators are sending it). The terminals and operators can then be removed and the RTE can emulate those same terminals it was previously observing. As it emulates the terminals/operators, the RTE also measures the response time of the test computer.

For our benchmark tests, rather than using human operators to set the parameters of the exercise, we provided the Burroughs team with the script used in our test and the other necessary parameters to describe our usual benchmark environment.

Our Observations

The Burroughs B91 uses what is commonly called a multidropped data communications structure. In a multidrop structure, more than one terminal may be put on a single line and multiple lines may be attached to the system. (In our tests, there were eight terminals sharing one line into the computer. The B91 allows up to two lines into the system.) On a multidrop line, the computer sends blocks of data to the terminals, and the terminals respond with blocks (or screens) of data. Each block typically consists of a header (terminal ID and other information), the data itself, and error check codes. The Burroughs protocol used on the B91 (called Multipoint Contention Protocol) is block

oriented as described above and uses asynchronous communications (character-by-character transmission where each character contains extra bits like start, stop, and parity bits).

To communicate, a terminal must check to see that the line is free, notify the computer that it has a message, and after sending the message, wait for acknowledgment of message received or a request for retransmission. When more than one terminal attempts to access the line at the same time, contention develops and must be resolved by the computer.

Handling these communications chores requires an intelligent terminal like the Burroughs MT983 system. The MT983, in addition to controlling the communication function, also provides other programmable features which make it suitable for the screen-oriented/form fill-out types of applications that are often done on the B91.

In order to relieve the application program of communications responsibilities, the B91 uses what might be called a layered or hierarchical approach employing specialized software modules to handle the communications tasks. At the lowest level (the data link), the Network Controller handles the physical data communications including functions such as polling, message buffer management, and error detection/retransmission. This level is programmable using NDL (Network Definition Language) and uses its own interpreter. At the next level is the MCS (Message Control System) which is written in MPL (Message Processing Language) and also requires an interpreter. The MCS provides the interface between the Network Controller and the application program. Its function may be to merely pass on messages to the application program (as in our tests) or it may perform other more complex activities including message routing, access control, message auditing, and recovery. All of this activity is transparent to the application user.

Typically, users will not find it necessary to design/program their own NC/MCS. This task will be done by Burroughs or the OEM so that the user need not learn NDL and MPL. Alternatively, the user might purchase GEMCOS (Generalized Message Control System) which allows specification of communications options, and then produces the MCS according to those specifications.

Though programming in NDL and MPL to set up a communications system for the B91 can be quite complex, it provides the OEM or the experienced user/programmer with enormous communications flexibility. This ability to, in effect, design your own protocols and communication methods is, in our opinion, one of the most unique and powerful features of the B91.

The order entry benchmark program used in the B91 tests did not use either of the two standard approaches we typically see for this application (multiple copies or a single copy of reentrant code). The Burroughs approach used a single program which received messages from the MCS message queue. The program took messages from the queue, analyzed the header to find the source of the message (which terminal sent it), determined the state of that terminal (what was done most recently and therefore what must be done next), took the appropriate action, and then sent its response. A full screen of information was communicated at a time using a form fill-out type of approach.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-Intensive job
- An I/O-Intensive job

"Real Life" Problems

- An Order Entry program run with varying number of terminals
- An Order Entry program run with varying number of terminals and background execution of the CPU-intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs

through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-8	Results:	N = 3000	8.0 seconds

Comment: *This time is for the CPU-intensive program using only multiplication and division. Therefore, this result should be compared to timings for benchmark Number A-8 (not A-4) in our other series of reports.*

<u>I/O-Intensive Job</u>

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	14.7 seconds

<u>"Real Life" Problems</u>

This program is based upon an order entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file.

When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

Order Entry Run in Production Mode

The order entry program was run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	*
D-2		4 terminals	*
D-3		6 terminals	*
D-4		8 terminals	*

*Comment: *The results using Burroughs' RTE are not strictly comparable to those in other reports using our own RTE. See the Analysis of "Real Life" Problem Results Section.*

Order Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-Intensive program continuously, with the order entry program running at the same time. Again, the measured times for the order entry program are the average processing times per transaction. The measured times for the CPU-Intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	*	*
E-2		4 terminals	*	*
E-3		6 terminals	*	*
E-4		8 terminals	*	*

*Comment: *The results using Burroughs own RTE are not strictly comparable to those in other reports. See the Analysis at "Real Life" Problem results section.*

Analysis of "Real Life" Problem Results

Though, as we've stated earlier, the benchmark techniques employed by Burroughs are very similar to our own techniques, there are enough differences (some with rather technical descriptions) to warrant our not featuring the times that were measured. Some of the differences include baud rate differences (our 300 baud versus their 9600), timing measurement differences (we measure to the nearest 1/100 of a second while they measure to the nearest 1/10), difference in application approach (they used a form fill-out approach while we use a line-by-line approach), and contention problems (their RTE cannot measure the amount of contention that takes place on the line and it is difficult to estimate).

We would like to emphasize that none of these differences in any way invalidates the Burroughs procedure but merely renders direct comparison with other BENCHMARK REPORT timings difficult at best. In our opinion though, and based on our observations of the Burroughs benchmark procedures and the B91 "in action," and if it was possible to adjust for all the differing factors, we would place the B91's timings roughly in the middle of the other timings we've observed in this series of reports. The actual Burroughs RTE timings were: D1 to D4 - 1.9 seconds to 3.0 seconds, E1 to E4 - 1.9 to 3.2 seconds with CPU-Intensive times of 8.5 to 10.2 seconds for the MPL version of the order entry program. For the COBOL version, the Burroughs RTE timings were: D1 to D4 - 2.4 seconds to 3.5 seconds, E1 to E4 were not done.

SYSTEM AS TESTED: BURROUGHS B91

Costs

• Base B91 with 128 kilobytes of main memory (includes built-in 90 cps printer and console keyboard)	$ 7,950
• Memory upgrade (128 to 256 kilobytes)	2,050
• Data communications control and harness	721
• 9.4 megabyte fixed disk drive	5,500
• 1 megabyte Super Mini-Disk drive	910
• 2 disk controls	1,980
• 1 MT983 Modular Terminal System	2,971
• 160 line-per-minute printer	6,480
Total System	$28,562

Our Observations

The following prices use the MT983 terminal at $2,971 each.

Configuration	Total Price
System with one terminal	$28,562
System with two terminals	$31,533
System with four terminals	$37,475
System with six terminals	$43,417
System with eight terminals	$49,359

All prices given above do not include software. The MCP (Master Control Program) and utilities cost $3,040. Compilers and other software developmental aids are additional.

Burroughs also offers the B92 which uses the same processor as the B91, but includes a larger backplane (which allows more I/O controller boards) and a faster built-in printer (120 cps, 14 inch wide forms) with a base price of $11,950. A user might elect to purchase the B92 with its faster printer and forego the line printer at a cost which would be $2,480 less than the "as tested" price reported above ($26,082).

Additionally, the newly announced B93 is the same as the B92 without the built-in printer and keyboard. Thus, a CRT must be added to the system to serve as the console terminal.

Summary of Equipment and Features

- The B91 comes with Burroughs' own four-chip, 2 MHz microprocessor and 128 kilobytes of main memory. Five K bytes of the memory is a ROM (read only memory) which contains some system software (bootstrap, etc.) and a Customer Confidence Routine. This routine does hardware checks and reports the results on the system console.
- Central memory can be expanded up to 512 kilobytes. A memory upgrade from 128K to 256K costs $2,050, from 128K to 384K costs $4,600, and 128K to 512K costs $7,150.

Our Observations

The B91 processor employs a technique more often found on larger computers called pipelining. This technique helps to improve processor speed and efficiency by overlapping the retrieval and execution of instructions. So at any point in time, the processor may be executing one instruction, decoding a second instruction, fetching a third from memory, and computing the address of a fourth instruction.

Users seemed generally pleased with the execution speed of their B91 system. Most were quite impressed with the hardware though several complained that the software is just now catching up with the capabilities of the hardware.

User Comments

- *In my opinion, up until the new software came out* (GAP II and operating system), *Burroughs had good state-of-the-art hardware, but they were using antiquated software. Now I feel it is a good system ... I'm impressed with the hardware and GAP II is a good piece of software.*
- *The system is pretty quick, though it does slow down a bit with all four of my terminals going.*
- *We've had seven or eight programs going at once with no problem.*
- *Its strong point is its multi-tasking ability. We often have as many as four programs running at one time.*
- *The B91 is a real timesaver for us. We're totally satisfied at this point.*

STORAGE DEVICES

Summary of Equipment and Features

- The Burroughs B90 series of computers offers a variety of disk storage subsystems including floppy, cartridge, and fixed disk drives. Each subsystem requires a disk controller and up to 2 controllers can be installed on the B91, and 3 on the B92. In addition, a magnetic tape cassette drive may be employed on the B92.

- The Burroughs Super Mini-Disk has a storage capacity of 1 megabyte per disk and the unit provides a maximum of two disk drives ($1,900 including controller). The Super Mini-Disk II uses one drive for a maximum of two disks, and provides 3 megabytes of storage per disk. In addition, the drive offers error correction techniques, automatic relocation of data from failing portions of the disk, special facilities to adjust for environmental fluctuations, and high speed search logic for file search operations such as sorting, etc. ($6,000 for 6MB).

- Cartridge disks are available and include a 4.6MB disk ($6,000) and a 9.2MB disk ($11,153). Fixed disk drives are available with capacities of 9.4MB ($6,490), 18.8MB ($10,490), 38.7MB ($15,490), and 77.0MB ($16,990).

- An industry compatible floppy disk drive is also available (243K bytes for $4,736).

Our Observations

Certainly one of the more impressive features of the B91 is the Super Mini-Disk II. Using advanced floppy disk storage technology, this drive can store 3 megabytes on a standard eight-inch floppy diskette (three times the industry maximum). This capability makes the floppy disk a viable method of backing-up fixed disk units and can eliminate the hassle and expense of magnetic tape backup.

The users we surveyed were satisfied with the storage capabilities of their system though there were a few complaints that the backup process took too long.

User Comments

- *The thing I like best about the system is the 3MB Mini-Disk. As a backup, it's great. It holds a lot of information on a relatively inexpensive storage medium.*

- *Our one megabyte backup takes too much time.*

- *The computer itself is a timesaver ... except for backup.*

Summary of Equipment and Features

- The B90 series of computers offers a number of terminals and display stations. These include CRT devices, remote printers, teller terminals, and an OCR page-reader.
- One of the most commonly used terminals is the MT983, a microprocessor based CRT and detached keyboard system. It features a variety of cursor control and display features, editing capabilities, and memory paging. It is capable of both synchronous and asynchronous communications ($2,971).
- Line printers for the B90 series start at a 160 line-per-minute printer for $6,480 to a 600 lpm printer at $14,980. A 90 character-per-second terminal printer (AP100) is also available ($5,150).
- The B90 systems offer a programmable communications interface which provides the flexibility to handle nearly any protocol in the industry. In addition, "off-the-shelf" data communications interfaces are available and include IBM 2780/3780 RJE, IBM 360/20 HASP, IBM 3270, and Burroughs RJE. Burroughs also plans to offer X.25 Packet Switch Interface and IBM SNA Interface for the B90 series.

Our Observations

As we said earlier in this report, we feel that the most impressive feature of this system is its data communications capabilities. Using the programmable data comm interface and NDL (Network Definition Language) or any of the "off-the-shelf" interfaces, the B91 can communicate with other devices using standard or even user devised protocols. With this flexibility, users are able to attach a wide variety of non-Burroughs terminals.

Users reported few problems with their terminals or printers. Several had purchased line printers when they found the console printer speed to be inadequate.

User Comments

- *The console printer is really nice with very legible print, but it is slow. We now have a line printer which we're real happy with.*
- *We use the console only sparingly ... other terminals are more efficient for input.*
- *The console printer is great. The 8½ inch paper works out well.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- The Burroughs Computer Management System (CMS) consists of the Master Control Program (MCP), utilities, languages, and other software development aids. For the B91, the MCP and utilities package costs $3,040.

- The CMS programming languages are COBOL, RPG (and RPGII), MPL (Message Processing Language), and NDL (Network Definition Language).

- CMS utilities include directory list, disk space analysis, disk compaction, list and copy files, compare files, SORT/MERGE, print system logs, and others.

- Software development aids (besides language compilers) for the B91 system include:

GEMCOS	- Generalized Message Control System. This is a Message Control System generator.
REPORTER	- This is used for interactive report specification employing a simplified questionnaire technique.
DOMAIN	- Used to develop file maintenance and inquiry programs from a terminal.
CANDE	- Command AND Edit language. Used for creating, maintaining, and test editing COBOL and MPL source files.
ARCS	- Automatic Run Control System. Used for automatic execution of repetitive command sequences and programs.
RPG-EDIT	- This is an interactive RPG source program editor.
ODESY	- On-line Data Entry System. Used for data entry and verification.

Our Observations

The B91 has a variety of useful operating system features and program development aids. As stated earlier in this report, we're quite impressed with the flexible and programmable data communications of the B91. Using a hierarchical approach to free the application programmer from communications tasks, the MCS (Message Control System) provides the interface between the application and the terminals.

The B91 implements all of its languages as "interpretive" languages. In addition to providing transportability advantages among other Burroughs

CMS systems, this approach allows the B91 to provide different environments for programs written in different languages. This technique, which Burroughs calls variable micrologic, lets the B91 change itself automatically to provide an efficient environment for each language as it occurs (for example, it can provide a stack-oriented structure for MPL or a memory-oriented structure for COBOL).

The Burroughs B91 CMS employs a standard line-oriented approach to operating system/user interaction. The user enters commands which invoke CMS intrinsics (like discontinue or restart program statements) or CMS utilities. Though the CMS operating system seemed powerful enough to us, we do feel that the system/human interface could be improved. Without using the menu-driven approach or providing a "help" command, the user is left with paging through detailed reference manuals in search of the information needed.

CMS provides indexed file capabilities which can be invoked by creating an index file with an application program or using the CMS SORT utility. The SORT utility offers sort and merge capabilities and will create a key (or index) file based on a user defined key. More than one key file may be specified for a given data file. The data file may be output in key file order by using the LIST utility to "list" the data file (actually the user lists the key file name and the utility checks the key file to find its associated data file).

The CMS Master Control Program (MCP) offers multiprogramming capability. The MCP is responsible for all aspects of executing multiple programs concurrently and for dynamic allocation of main memory to the programs.

The users we spoke to in our survey were not doing any in-house programming. For this reason, most had little, if any, comments about the operating system. There were a few comments on some utilities and other programs which indicated that the users were satisfied with those utilities they did have occasion to use.

User Comments

- *I like REPORTER very much. It gives us flexibility.*
- *We use DOMAIN extensively and we like it.*
- *One disadvantage to REPORTER is that once you create a report, and if you make a mistake, there is no way to correct it ... you must start from scratch again.*
- *Burroughs utilities? Well they're necessary to perform the work, and they do it just fine.*

LANGUAGES AND APPLICATIONS PACKAGES

Summary of Features

- The B91 offers four compiled languages including Network Definition Language ($900), Message Processing Language ($900), RPG and COBOL. NDL is used for implementing or reconfiguring a data communications network while MPL provides interfacing for user programs to NDL and other message control functions. RPG and COBOL do not have a purchase price, but can be leased for $25 per month.

- A large number of applications packages have been developed by Burroughs for use on the B91. These packages, which range in price from $1,400 to $19,000, include:

  - Mfg. Job Accounting
  - Contractor Business Mgmt.
  - Credit Union
  - Utility Billing
  - Mfg. Production Control
  - Distribution Mgmt.
  - Hospital Business Mgmt.
  - Governmental Tax Billing
  - Commercial Business Mgmt. (A/R, A/P, Payroll, etc.)

Our Observations

All the language compilers on the B91 convert the source code to what Burroughs calls "S-code" or "pseudo-code." This "S-code" is then executed by that language's run-time interpreter (there are interpreters for MPL, NDL, and a common one for COBOL and RPG). The "S-Code" generated is independent of any particular hardware, so it can be run on several other Burroughs systems including the B92, B93, B920, and the B1900. This "object-code" compatibility allows application software to be transportable through the CMS family of computers without requiring modification or even recompilation.

None of the users we surveyed were doing any in-house programming, but 12 out of 14 were using Burroughs applications packages. Their comments indicated that, in general, they were quite satisfied with their system.

User Comments

- *I like Burroughs packages very much ... and we get excellent service.*
- *GAP II* (General Accounting Package) *is really a snap to use.*
- *There are a few problems with our packages, but overall the software is fantastic.*
- *The Utility Billing program is super and we get really good software service.*
- *Our packages are working pretty good. We're going through them by trial and error ... learning how to use them and what they can do. Our only problems have been from a lack of familiarity.*

Summary of Features

- All hardware and software maintenance on the B91 is done by Burroughs. Their standard maintenance contract covers all parts and labor on a 8 to 5, five days a week basis.
- Burroughs provides training courses for B91 users including a general customer education course and other courses covering specific application packages. In addition, if desired, a user may participate in a workshop in which Burroughs personnel work through the start-up phase with the customer.
- Toll-free hotlines are available covering system software and specific applications packages.

Our Observations

The B91 documentation we examined consisted primarily of reference-type manuals which are most helpful when the user knows what to look for, but are not useful as a familiarization tool. We do feel that there should be a place within a vendor's line of documentation for a manual which gives an overall description of the system (hardware/software features and capabilities, etc.) in a language a computer neophyte can understand. We would hope that Burroughs might offer this type of "user-friendly" documentation in the future.

The users we contacted were very pleased with the training, service, and support they had received from Burroughs. There were occasional complaints about the documentation.

User Comments

- *Burroughs has really got its act together with the regional training centers. It's better than having training in the office environment with all the interruptions.*
- *The documentation is good. The training is really good ... besides being informative, it was fun!*
- *Documentation is an area that needs improvement as it's often hard to follow. For a first-time user, it's impossible ... always chasing through the books.*
- *Had a couple of problems, but their service has been tremendous ... more than tremendous.*
- *We've had only minor problems. The service has ranged from good to very good.*

SUMMARY OF USER COMMENTS

Through telephone interviews and using names supplied by Burroughs Corporation, we surveyed 14 end-users of the Burroughs B90 series. These users (split evenly between the B90 and the B91), had owned their system from five months to a year. They included two banks, a credit union, two contractors/builders, a public accountant, two public utilities, a manufacturer and a medical billing office. The systems were being utilized 4 to 18 hours a day, two to six days a week.

Many of these firms had evaluated other well known computers before deciding to buy a Burroughs. They based their decision on factors that included software packages available, price, expansion capability, compactness of the system, software and hardware from the same manufacturer, company image, and the fact that they already had Burroughs products.

The standard hardware configuration was 128K bytes or 256K bytes central memory, 1 or 3 megabyte mini-disks, 9 or 18 megabyte fixed disk, and in some cases, tape cartridges. Over half the users had Burroughs line printers, four had only the self-scan screen, and others had from two to four additional terminals. Hardware dependability ranged from no problems at all to one user who has been having cronic problems (but he still likes his Burroughs). Generally, the hardware required only minor service and the turnaround time for service was quite good. Users felt that Burroughs' representatives for software and hardware were very helpful.

The B91's keyboard and built-in console printer received mixed reviews, with some users very pleased by the arrangement and others rather unhappy with it. Several users especially liked the 3 megabyte Super Mini-disk because of its large storage capacity. The self-scan CRT on the console (no longer produced) was being used only sparingly, and some users said it worked fine while another person said one of its drawbacks was that the messages don't stay on the screen long enough.

All but two of the users were using Burroughs application packages, and none were doing in-house programming. They were very pleased with these packages and, just as important, the software support they received from Burroughs.

One of the users didn't like the software he had initially installed and had even considered getting a different computer. After Burroughs came out with the GAP II package and a new release of their operating system, he now thinks their software matches their state-of-the-art hardware. One comment was "The accounts payables package is just super. There are a few problems with the packages, but overall Burroughs' software is fantastic." In addition to service personnel these users had access to Burroughs' hot-line and cited it as a great help.

COBOL was the language being used by all those surveyed with two users also running programs in RPG. When asked about REPORTER, DOMAIN, and CANDE, those that used these packages indicated that they liked them. CANDE was being used for backups and multiple file sorts, and one user said DOMAIN was "excellent."

Central memory was "ample" for users' applications and fixed disk storage of 9 to 18 megabytes was enough for some and not enough for others. Users said the system slowed down with all of their terminals running or when using the console and a remote terminal. One user said speed seemed to be disk bound and he thought that if he went to 40 megabytes it would increase. System speed though, was not a problem and only a minor inconvenience when users were doing backup routines.

Burroughs got its highest marks for their week-long training for end-users. Users said it was excellent, the instructors were knowledgeable, and it was instructive as well as fun. Criticisms of the training were that it was too expensive or that the material could have been covered in two or three days instead of five. Documentation, often a weak spot in a system, was no exception in the Burroughs package. Useability varied because some felt it was too technical or was a good reference for normal operation, but not when a problem came up. Others didn't refer to it very much or said it was fine.

This group of users was very enthusiastic about the B91 and B92. Many picked the system because they felt Burroughs software best suited their needs. They reported receiving thorough training to use the system, hardware that was dependable, and software that didn't need major modification. When software "tailoring" was required, it was done by qualified personnel on a timely basis. In short, they were happy with their Burroughs system and were confident they had made the right choice.

CONCLUSIONS

In this report we have reviewed the Burroughs B91 computer system (which includes a built-in printer and keyboard, 256K bytes of memory, a 9.4 megabyte hard disk, and a 3 megabyte floppy disk). In a normal configuration, the B91 uses multidropped terminals and block-oriented communications. Because of this, we could not interface our Remote Terminal Emulator with the B91. However, Burroughs has an RTE which is very similar to ours in concept, and ACU chose to have us observe benchmark runs on the B91 using our programs, but with Burroughs' RTE. For the I/O- and CPU-Intensive runs at a single terminal, we followed our standard procedures.

We used Message Processing Language (MPL) for all of the runs, and also tested COBOL on the order entry program. While there was some degradation in response times as terminals were added, the COBOL was somewhat slower than MPL, all times were well within the acceptable range. We cannot directly compare these times to others in this series because of the block-oriented form-fillout nature of the application, and because we did not use our own RTE.

The Burroughs B91 can be programmed in NDL (Network Definition Language), MPL (Message Processing Language), COBOL, and RPG. We were particularly impressed with the communications capabilities of the B91, where the NDL can be used to define line protocol, or Burroughs packages can be used for standard protocol (such as HASP, 2730/3780, etc.). Another important feature is the eight-inch floppy disk system where each disk holds up to 3 megabytes of information. There were several utilities for interacting with the file system, as well as editors for each language. Finally, Burroughs offers a range of applications packages, including general accounting as well as specialized packages for specific industries such as contractors, hospitals, credit unions, etc.

Users were very happy with the B91 system, particularly with the extensive training and support given by Burroughs. Those using packages were very satisfied with performance. The only negative comments, with which we concur, dealt with the documentation, which was impossible to learn from and difficult as a reference.

Overall, the Burroughs B91 appears to us to be an excellent machine. As one user commented, it represents state-of-the-art hardware with software that is quickly catching up with the capabilities of the machine.

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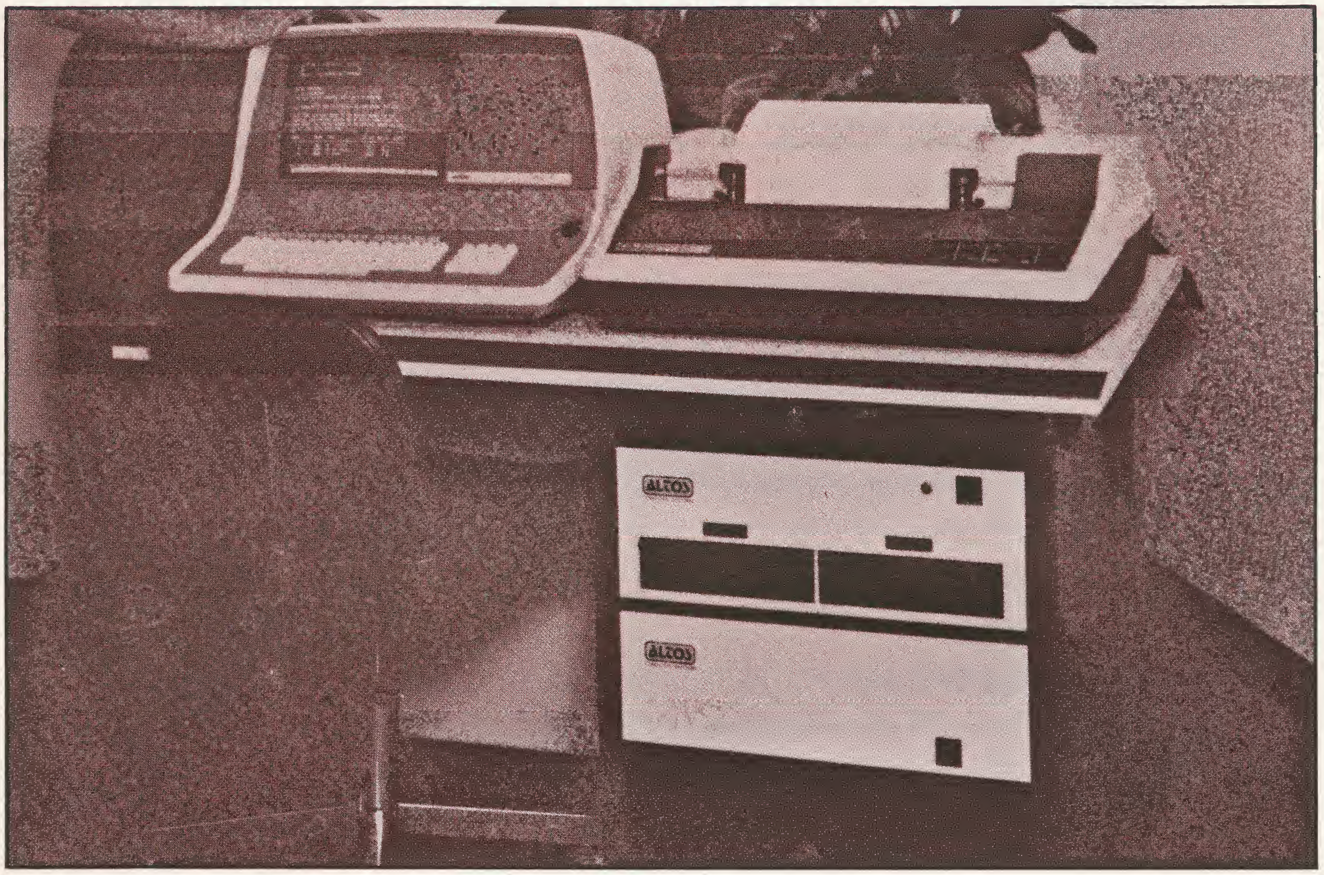

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ALTOS ACS8000-10: BENCHMARK REPORT

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PREFACE

The Altos ACS8000-10 is the subject of our tenth report in this series covering multi-user systems. The purpose of these reports is to provide comparative information which will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source.

A large variety of hardware and software approaches have been used by the various systems reviewed in this series. Though manufacturers usually supply an overabundance of information, it is often highly technical and difficult to understand. Many prospective purchasers find it difficult to relate this information to the "real life" performance of the system. "First-timers," especially, are interested in the system's ease of use and other "soft" factors which are difficult to ascertain from the vendor's technical information.

Many prospective users are finding themselves overwhelmed by the task of sorting through all of the information available to them. We feel that these BENCHMARK REPORTS help to reduce this "information overload" by providing an unbiased assessment of many of the minicomputer systems now on the market. Our results, which are comparable across computer systems, and our observations of the system in a "real world" setting, can help experienced and inexperienced users alike intelligently select a system that is best for them.

The heart of these reports is the results of running three benchmark programs on each system under study. Two of the programs are identical to those found in the Series 1 and Series 2 reports and provide comparability with the single-user systems covered in those reports. The third is a multi-terminal order-entry program specifically designed to measure degradation in response time as terminals are added to the system.

In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating systems, utility and application programs, and overall ease of use. This information will be based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Altos ACS8000-10 used in our tests consisted of a Z-80A processor, 208 kilobytes of main memory, a single-sided, double-density floppy disk (one megabyte capacity), a ten megabyte hard disk, one parallel and six serial I/O ports, and OASIS Multi-User Operating System. As peripherals are not a part of the Altos "package," we supplied a terminal and printer. When configured with a Hazeltine 1420 terminal and a Texas Instruments Model 810 printer, the system is priced at $12,340. A four terminal system (the maximum configuration) would cost $15,625.

- The Altos ACS8000 series of microcomputer systems are based on a single board technology. Rather than separate boards for the processor, memory, and disk controller, the ACS8000 uses a single board for all of these components.

- The ACS8000-10's timings on the order-entry benchmark place it about in the middle of those we've observed to date (for two and four terminals). The results on the CPU-Intensive test were less impressive though, with times far slower than the others we've seen so far in this series.

- There is a wide variety of languages available for the ACS8000 including BASIC, Pascal, FORTRAN, COBOL, APL, and PL/1. In addition, Altos offers asynchronous, synchronous, and networking communications software plus some word processing applications. Other business application software is available from Altos dealers and software houses.

- The ACS8000-10 is limited in both disk capacity and number of simultaneous users (four). We feel these restrictions, in combination with the inherent limitations of an 8-bit microprocessor, make comparisons difficult between this machine and others we've examined in this series of reports. Nonetheless, as a multi-user microcomputer under the OASIS operating system, we were impressed with the capabilities of this system and especially with its price.

- After repeated requests, Altos did not supply us with user names for our survey. Any user comments that are included are extracted from our user survey of a single-user Altos system (the ACS8000-15) published in our BENCHMARK REPORTS, Vol. 3.3. We attempted to use comments from that survey that would be relevant, but it must be noted that the system tested in that report differs from the ACS8000-10 tested here in the type/size of disk used, operating system, programming language, and often in the number of users accessing the system.

The ACS8000-10 with the OASIS operating system is a capable microcomputer system. Though its limitations make comparison with the other systems we've tested difficult, we feel that the price/performance ratio of this system makes it capable of serving the data processing needs of many small business users.

BENCHMARK REPORT

SYSTEM: Altos ACS8000-10

PRICE AS TESTED: $12,340

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-4	N = 3000	305.5 seconds
	I/O INTENSIVE	
B-4	N = 3000	82.5 seconds

"REAL LIFE" PROBLEMS

Benchmark Number		
	ORDER ENTRY	
D-1	2 terminals	5.4 seconds
D-2	4 terminals	6.9 seconds
D-3	6 terminals	*
D-4	8 terminals	*

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program *	Order Entry Program
E-1	2 terminals . .	473.1 seconds	6.8 seconds
E-2	4 terminals . .	*	*
E-3	6 terminals . .	*	*
E-4	8 terminals . .	*	*

Note: Order-Entry program times represent average processing times per order-entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

*Four is the maximum number of terminals that can be run on the ACS8000-10.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Altos and requested their assistance in benchmarking the ACS8000. Though the ACS8000-10 as tested does not fall within the price range quoted for this series of reports ($25,000 to $50,000), ACU has noted that the Altos system was often being compared to other systems we've tested in this series. Thus, the decision to benchmark the ACS8000 was made so that we might see how this machine "stacks up" against the more expensive systems we've tested. (NOTE: Had Altos supplied us with a "full-blown" ACS8000-7DS/MTU, a system with 29 megabytes of hard disk and a magnetic tape cartridge drive, a four terminal system with printer would have cost about $21,000...more in line with our price range, though still the same processor and memory.)

Altos provided us with an ACS8000-10 at our offices in Boulder, Colorado. The system consisted of a Z-80A microprocessor, 208 kilobytes of main memory, a ten megabyte hard disk, and a one megabyte floppy disk. We supplied a terminal and printer for the system. Altos also provided programming and other on-site technical support during the benchmark testing.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the ACS8000-10) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and Series 2 reports).

Benchmarking the ACS8000-10

Two days were required to benchmark the ACS8000-10. After correcting several "bugs" in the order-entry benchmark program supplied by Altos, we established communication between the Altos system and our RTE. We then set up the necessary procedure files, etc., and the benchmarks were routinely completed.

Our Observations

We must admit, at first glance, it would be easy to be skeptical about what a Z-80 based system could do "up against" the formidable 16-bit machines we've tested to date. We do feel that the ACS8000's inherent limitations in disk capacity and, especially, its four-user maximum, place it in a different "class" than the other systems we've examined. The Z-80A, though powerful, simply cannot accomplish what a capable 16-bit CPU can.

Nonetheless, we were favorably impressed with the ACS8000-10. We found that, in combination with the OASIS operating system, the system provided many features and capabilities found on larger (and definitely more expensive) machines.

The OASIS operating system uses a line-by-line command structure as opposed to a menu-driven type of approach. To aid the user, extensive "help" is available on-line in the form of a HELP command. This command, if invoked alone, will give some information on nearly every OASIS command available. When invoked in conjunction with a particular system command, HELP will provide information on that command alone.

OASIS provides a user accounting system which can restrict access to the system through a log-on procedure which requires that the user enter an ID and password. Users can be restricted as to which system commands they can access (via setting privilege levels) and files can be set up with limited access. In addition, a system log is maintained which records user activity on the system.

Command or procedure files may be set up and executed by the OASIS EXEC processor. EXEC files may contain multiple OASIS commands and may be passed parameters when executed. IF statements, arithmetic operations, and CRT screen control make EXEC files highly flexible and powerful. Programmers

may set up complicated procedures which a user may easily invoke. IPL (Initial Program Load) EXEC files may also be created for any user so that when an operator logs on, commands may be automatically executed.

The OASIS BASIC used in our tests is an enhanced version of Dartmouth BASIC. It supports four types of file structures including sequential, direct, indexed sequential, and keyed. Other features are matrix manipulation statements, structured statements (IF ... THEN ... ELSE and WHILE ... WEND), and an operating system command interface capability. Chaining and linking of programs is allowed so that large programs may be segmented.

One enchancement missing in OASIS BASIC that we have enjoyed in other extended BASIC's is the ability to label subroutines and CALL the routine rather than use line numbers and GOSUB's. It also appears that OASIS BASIC mathematical routines (especially exponentiation and square root) are less than optimal given the timings observed on the CPU-Intensive program (by far the slowest we've observed to date).

When multi-user OASIS is first booted into the system, there is only one memory partition (number 1) that uses all available memory in the first bank of memory. To allocate partitions, SET MEMORY commands are used. In the system as configured for our tests, we created five partitions, three with 48 kilobytes of memory (a full bank), one with 44 kilobytes, and one with 4 kilobytes. The system SPOOLER resided in this final partition. Several more commands are required to "start" (allocate an I/O device and set other parameters) the partitions, but this was easily handled by an IPL.EXEC file which executed these commands on system start-up.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-Intensive job
- An I/O-Intensive job

"Real Life" Problems

- An Order-Entry program run with varying number of terminals
- An Order-Entry program run with varying number of terminals and background execution of the CPU-Intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	305.5 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	82.5 seconds

"Real Life" Problems

This program is based upon an order-entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

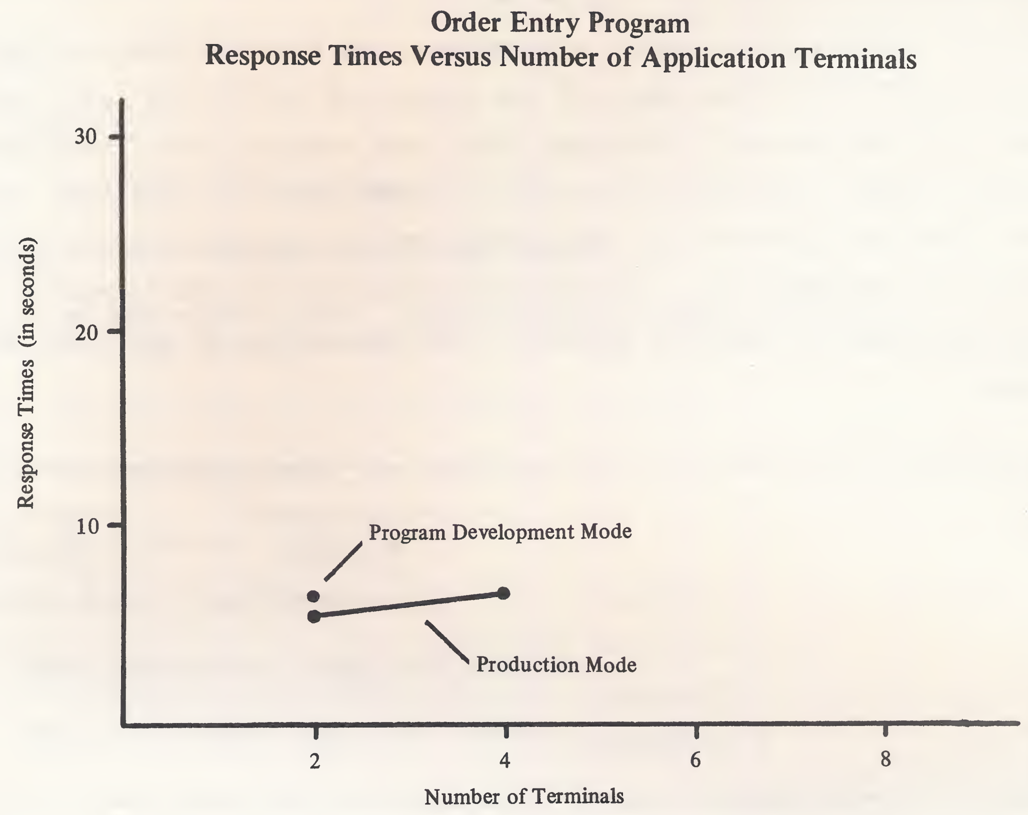
Order-Entry Run in Production Mode

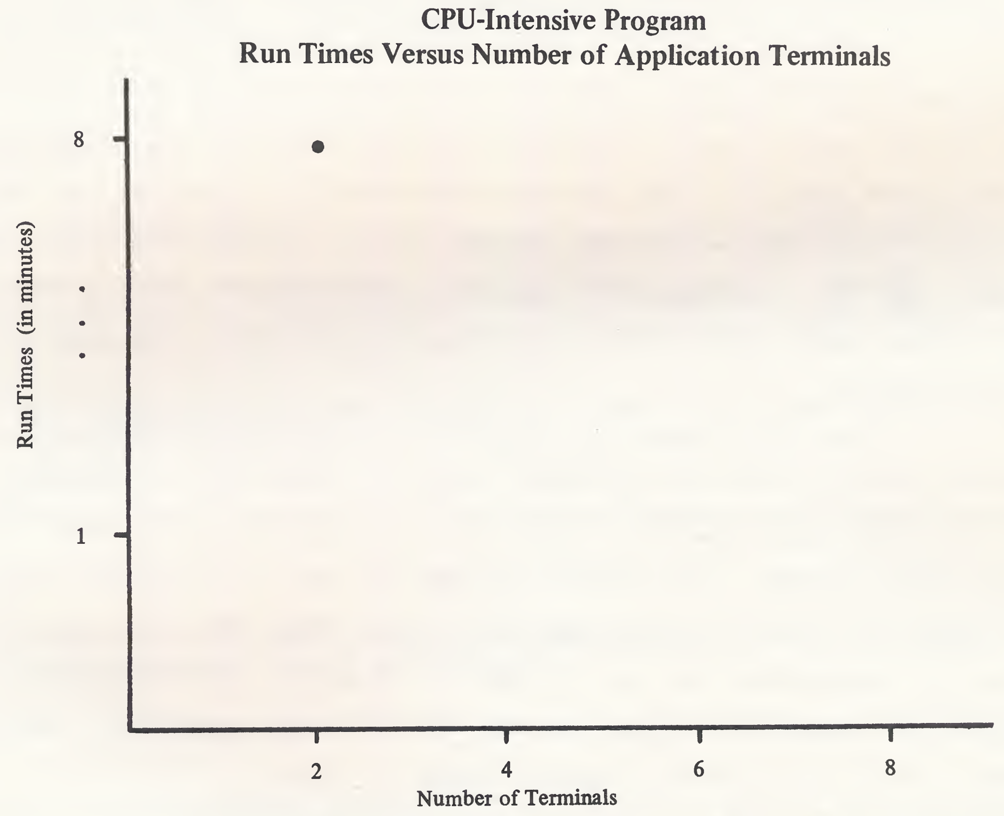
The order-entry program is run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

D-1	Results:	2 terminals	5.4 seconds
D-2		4 terminals	6.9 seconds
D-3		6 terminals	*
D-4		8 terminals	*

Comment: *Four is the maximum number of terminals that can be run on the ACS8000-10.*

BENCHMARK TIMINGS: ALTOS ACS8000-10





Order-Entry Run with Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-Intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-Intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	473.1 seconds	6.8 seconds
E-2		4 terminals	*	*
E-3		6 terminals	*	*
E-4		8 terminals	*	*

Comment: *Five terminals are required to run the four terminal test (the fifth terminal runs the CPU-Intensive program). This exceeds the four terminal maximum of the ACS8000-10.*

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for two and four terminals without the background program running (production mode) and a single point for two terminals with the background program running (program development mode). The second graph shows the CPU-Intensive time when two terminals are running.

The ACS8000's timings on the two and four terminal order-entry benchmark, though not extremely fast, place it about in the middle of the timings we've observed on other systems. This cannot be said for the CPU-Intensive program, where the times were far and away the slowest we've observed to date. The OASIS system does allow the user to SET the timeslice of a program so that it might have been possible to speed up the CPU-Intensive program by "sacrificing" some of the order-entry program's time.

SYSTEM AS TESTED: ALTOS ACS8000-10

Costs

ACS8000-10

• Z-80A microprocessor	$ 8,500
• 208 kilobytes of central memory	
• One single-sided, double-density floppy disk drive (one megabyte total)	
• One parallel and six serial I/O ports	
• One eight-inch, ten megabyte hard disk	
• Hard disk controller	
Hazeltine 1420 CRT terminal	$ 1,095
Texas Instruments Model 810 printer	$ 1,895
OASIS Multi-User Operating System	$ 850
Total System	$12,340

Our Observations

A maximum of four terminals may be put on the ACS8000-10. We have priced in the Hazeltine 1420, though nearly any standard "dumb" terminal can be interfaced.

Configuration	Total Price
System with one terminal	$12,340
System with two terminals	$13,435
System with four terminals	$15,625

All Altos systems come "unbundled" (software is not included in the price). The OASIS system used in our tests includes OASIS BASIC.

User Comments

(Altos did not supply any user names for us to use in evaluating user responses to the ACS8000-10.)

Summary of Equipment and Features

- The Altos ACS8000-10 is a small, portable unit that easily fits on top of a conventional desk. Housed in the main chassis are the floppy disk drive, the hard disk drive, the CPU, main memory, and controllers.
- The ACS8000 series of computers uses a single circuit board which contains the Z-80A microprocessor, 208 kilobytes of main memory, and all the I/O controllers. This board is fully socketed for easy chip replacement.
- The 208 kilobytes of main memory in the ACS8000 are partitioned into four user blocks of 48 kilobytes each (16 kilobytes are left for the system). Direct Memory Access (DMA) is standard on the system (this allows I/O controllers to access memory without going through the CPU).

Our Observations

The Z-80A microprocessor is a capable 8-bit CPU which is widely used in the microcomputer industry. Due to its popularity, there is a large amount of software available on the market that can be used on Z-80A based systems.

The ACS8000 uses a single board for its processor, memory, and disk controller. The absence of any motherboard or slot-type configuration does preclude expansion of the memory or controllers of the system.

The four terminal maximum of the ACS8000-10 system is a function of the limitations of the single-board system and the "power" of the Z-80A processor. Though we feel that the ACS8000 performs well for a multi-user microcomputer, we do feel that this is a severe limitation to many users. Altos has announced a new 16-bit system based on the 8086 processor which should expand the Altos line to include a larger, more powerful multi-user system.

User Comments

Summary of Equipment and Features

- The ACS8000-10 comes with a single-sided, double-density floppy disk drive which has a one megabyte capacity. Two additional drives cost $3,000.
- The -10 is also equipped with a ten megabyte hard disk which employs Winchester-type technology. This unit, if priced separately, costs $4,000 including controller.
- A magnetic tape cartridge backup unit may also be purchased for the ACS8000-10. Each MTU cassette will store 13 megabytes of data. A stand-alone unit is priced at $3,500 or the ACS8000-10 can be purchased with the MTU in place of the floppy for $10,990.
- Instead of the ACS8000-10, a user may purchase the ACS8000-6 or -7 which employ 14-inch hard disk drives (housed in a separate chassis). These systems differ from the -10 only in the type/size of hard disk used. The -6 has a 14.5 megabyte capacity ($10,490) while the -7 has a 29.0 megabyte capacity ($11,490).
- The ACS8000-10 can be expanded to a total of two hard disks, one magnetic tape unit, and four floppy disks. The -6 or -7 can add a single 14-inch hard disk and a magnetic tape unit.

Our Observations

It is surely in this area of disk storage capacities and prices that we have seen the most dramatic changes in the computer industry. Employing Winchester-type technology (sealed unit with floating heads), the drives have become smaller in size, more durable, and most importantly, less expensive. The eight-inch ten megabyte drive used by Altos (made by Shugart) fits in the same space as an eight-inch floppy disk drive, holds ten times as much data, performs considerably faster, and only costs about $3,000 more.

Though we did not have a chance to test the tape cartridge system, Altos reports a steadily increasing demand for systems with this feature. We feel this type of backup system is a very good buy given the value of a business' database and the cost of alternative systems available on the market.

User Comments

Summary of Equipment and Features

- Any standard RS232C compatible non-intelligent terminal can be attached to the ACS8000. Prices for this type of terminal generally start at $600.

- Similarly, a variety of printers may be attached to an Altos system. The ACS8000 contains one parallel and six serial I/O ports so that parallel or serial printer interfaces can be accommodated.

- As options, Altos offers a floating point processor ($300), a rack mount ($100), and a prototype board ($200).

- To accommodate networking, an RS432 communications port is standard. This port supports 800 kilobits transmission speeds for inter-computer communications.

Our Observations

Though Altos does not offer terminals and printers as part of a system package, most users will typically buy an ACS8000 from a dealer who has added terminals and printers of their choice. This flexibility can be a great plus for the prospective user, but it does make the user very dependent on the dealer or forces the user to select the peripherals on his own.

The OASIS operating system we tested does include a SPOOLER to allow printing operations to take place without suspending a user's other activities. The SPOOLER uses its own partition of about 3500 bytes which can be located in any memory bank.

User Comments

Summary of Features

- The OASIS operating system we tested ($850) is available in both single-user and multi-user versions from Phase One Systems, Inc. In addition, the multi-user system MP/M from Digital Research is also offered ($450).
- Other software and utilities available for the ACS8000-10 include:
  - ASYNC (by Altos) which supports asynchronous communications between the ACS8000 and a remote system.
  - SYNC (by Altos) which enables synchronous communications using IBM 2780/3780 protocols.
  - CP/NET (by Digital Research) which allows several microcomputers to access common resources.
  - KSAM 80 (by Efficient Management Systems), a multi-keyed ISAM.
  - MAC (by Digital Research), a Z80 macro-assembler.
  - SID (by Digital Research), a symbolic instruction debugger.

Our Observations

The OASIS operating system by Phase One Systems consists of a system nucleus, a Command String Interpreter, and various programs and utilities. The system nucleus (which is resident in the systems' 16 kilobyte partition) controls the scheduling, memory management, and system resource sharing of multiple users. Associated with the nucleus are the device driver programs which contain instructions designed to handle one specific device.

The OASIS system employs a standard line-by-line approach using a job control language (the commands and directives of the OASIS system). To aid the less experienced user, a HELP command is available. HELP may be invoked alone or with a specific command and provides information about the command and its associated parameters.

OASIS supports user accounting and restricted file access between user accounts. This user accounting includes keeping track of the time each user is on the system and allowing a user access only to public files, his own files and programs, and those select programs and files of other users who have given explicit permission to access them. User accounts can be set up with privilege levels which help to control user access to various system commands and procedures.

A procedure processor called EXEC allows the user to set up a file of OASIS commands (a procedure file) which can be executed by the EXEC processor. This feature allows the user to build a vocabulary of commands which

accomplish tasks requiring more than one OASIS command. Arguments can be passed to EXEC files so that flexible procedures can be designed.

Other features of OASIS include:

- DIAG — This is a set of diagnostic and repair routines. It provides programs to do such things as test memory, examine/update the system error message file, and run diagnostic tests on the disk drives.
- EDIT — This text editor is line oriented and features a HELP command to assist the user. Its commands include global search and replace and the use of macros.
- SCRIPT — A documentation processing system, this was designed primarily for the generation of documents and manuals. It features provisions for creating and maintaining page headings, text justification, table of contents, etc.
- COMM — Three programs designed for inter-computer communications. SEND and RECEIVE provide for the transmitting and receiving of data while TERMINAL allows the OASIS system and its console to act as a terminal to another computer system.
- MACRO — A two-pass symbolic assembler for the Z-80A CPU.
- LINK — A program to link together the output of an assembly or compilation process into an executable load module.
- DEBUG — A program which allows on-line interactive debugging of a program.

User Comments

LANGUAGES AND APPLICATION PACKAGES

Summary of Features

- The language used in our tests was OASIS BASIC, which is included as part of the OASIS system package.

- A variety of other languages are available on Altos systems including at least three other versions of BASIC, several versions of COBOL, Pascal, and also FORTRAN, APL, and PL/1. These languages range in price from $150 to $850.

- Though Altos itself does not develop application packages, a large number are available from a variety of sources. Altos publishes a 45 page SOFTWARE GUIDE which lists operating systems, languages, and application programs which can be used on the ACS8000 computer family. The applications listed include the "Big 5" accounting applications, word processing, vertical market software (e.g., real estate, law firms, medical offices), database management, graphics, and so on.

Our Observations

The OASIS BASIC we tested is an extended version of BASIC with a number of features that make it a useful business application programming language. These include:

- Support of four types of data files: sequential, direct, indexed sequential, and keyed.
- Common functions to handle cursor control.
- Chaining and linking of programs to allow for segmentation of large programs.
- User defined program keys.
- Matrix input/output and assignment statements.

OASIS BASIC has features of both an interactive language (the user may make changes to a program and immediately re-execute; immediate mode, etc.) and a compiled language (faster, more compact code; protection of the source code).

User Comments

Summary of Features

- The documentation used in our tests consisted almost exclusively of the OASIS System Manual, OASIS BASIC manual, and other OASIS documents. In addition, we received from Altos other documentation covering various software and technical hardware information.
- Service on the ACS8000 systems is done through Altos' distributor network. Any Altos vendor can offer service on the ACS8000 systems after sending a technician to Altos' maintenance training class. Prices and types of maintenance contracts/coverage are left to the vendor's discretion. Software support is handled exclusively by the vendors or the systems houses that supply the packages.
- Dealers are the primary source of training for the ACS8000 user.

Our Observations

We found the OASIS manuals to be well organized, easy to use, and all around very helpful. Numerous examples help to make the textual explanations of statements and procedures clear.

Of the users we spoke to in our single-user system survey, most were satisfied with the service they received from their dealers and nearly all praised the hardware reliability of their Altos system. As is often the case though, comments were varied regarding the documentation from the dealer on their application program(s).

User Comments (taken from the Benchmark report on the Altos ACS8000-15)

- *I wish there was a good manual for those of us who do not understand "computerese;" then we would not be so dependent on the dealer.*
- *We've had few hardware problems, but when they have occurred, the service from our dealer has been good.*
- *The documentation is so-so. At first, it was more than I could understand, but now, there's not enough information.*

SUMMARY OF USER COMMENTS

Altos did not supply any user names for us to use in evaluating user response to the ACS8000-10. The following is the Summary of User Comments from a single-user system survey (the Altos ACS8000-15) published in Vol. 3.3 of BENCHMARK REPORTS. Please note that this survey focused on a single-user system with the same processor and memory as the ACS8000-10, but different peripherals, operating system, etc.

Using names supplied by Altos, we contacted ten end-users of the ACS8000 series of microcomputers. These firms included a radio station, three manufacturers, a wholesaler and a textbook firm. Their applications consisted primarily of word processing and standard accounting.

The firms in our survey had first evaluated systems manufactured by DEC, Wang, IBM, Radio Shack, HP, Data General, Ohio Scientific, North Star, and Alpha Micro. In almost half the cases, users had initially been considering a dedicated word processing unit, but felt the Altos system offered a "general purpose" system rather than a "single purpose" machine. Other reasons for buying the ACS8000 were price, flexibility, hard disk and multi-user capability, and the availability of languages other than BASIC.

An average of three different people in each firm were using their Altos system eight hours a day, five days a week. In most cases, the interviewee had little previous background with computers. To them, the operating system was transparent as they were using "turnkey" packages and simply running their information through the system. Most of the firms had bought "off-the-shelf" packages (four had Word Star and rated it very highly) or other third-party software (only two users were doing some in-house programming).

User hardware configurations varied somewhat with about half using a hard disk (14.5 or 29.0 megabytes) and two floppy disk drives while others had only the dual floppies. One user had the magnetic tape cartridge drive and thought it was excellent. Another user, in addition to employing the ACS8000 as a standalone computer, was using Altos' ASYNC package to communicate with a timeshare bureau computer.

The users we talked to had from one to four terminals connected to their system and included such brands as Lear-Siegler, ACT, and Soroc. For one person, being limited to a maximum of four terminals was considered a drawback of the ACS8000. Printers being used included NEC, Centronics, and Texas Instruments.

Most users felt they had enough storage, though one user was going to have to add a hard disk. Another user noted that MP/M "divides the hard disk into three sections" and "uses more space than it should." Central memory size was generally regarded as just "adequate," but when a problem with program size did occur, chaining was used to "program around it." The 48K user partition was frequently cited as a limitation.

Hardware reliability for these users was exceptionally good, with only one user reporting "terrible" service from the Altos dealer (this user also reported that software support from that same dealer was very good). Nearly all the other users we surveyed were also receiving good support from their suppliers.

Feelings about documentation for the Altos system were, as usual, quite varied among the users to whom we spoke. One person suggested that if the documentation were more complete, they would be less dependent on the dealer, while others reported not using the documentation at all. Some thought the documentation was "easy tc read" and "really pretty good," while others felt that it was "hard to read" and that it "didn't fully explain all the functions inherent in the system."

The ten users we surveyed were all very pleased with their Altos system. They reported dependable hardware and good dealer service. Most were using CP/M and MP/M compatible software "as is" or with minor modifications. Many saw documentation as an area needing improvement, but they were overall, as one user put it, "delighted with the Altos system."

CONCLUSIONS

The Altos ACS8000-10 is a Z-80A computer system which will handle up to four simultaneous users. While several manufacturers have recently expanded their Z-80 based systems to multi-user capabilities, this is the first we have tested, and is a system specifically designed for multiple users.

The operating system can be a critical factor in performance, and we used the OASIS system, though MP/M is also available. We were very impressed with the capabilities of OASIS, including system accounting, utility commands, file and record handling, resource management, etc. It appears to be better integrated and easier to use than the current MP/M system available.

BASIC under OASIS is an enhanced version with structured programming statements, matrix manipulation, cursor control functions, and user defined program keys. Other languages available on the Altos include FORTRAN, COBOl, Pascal, and the full range of languages and software developed for CP/M systems. The system's performance on the CPU intensive program was the slowest we've seen, though its performance on the Order-Entry program places it in the middle of the two and four terminal times (which, in our opinion, is close to the maximum number of terminals a Z-80A could support).

Users (from our survey of single-user oriented systems) were happy with the reliability of the hardware. Most were using packages and could not comment on programming problems. They picked the Altos as a general purpose alternative to buying a word processing system or small single-user system.

If you are considering a small system, this multi-user Altos system provides an excellent price/performance alternative worth considering. Using MP/M, it is easy to program for multi-tasking (where each user is performing a different task) and with OASIS it is a capable multi-user system (where each user may be accessing the same files for updates). If you are looking for a system with the ability to perform several relatively simple tasks simultaneously, then the Altos is a good buy. On the other hand, if you need a powerful multi-user system and are considering expansion, then the performance of the Altos might be a limiting factor.

BENCHMARK REPORT

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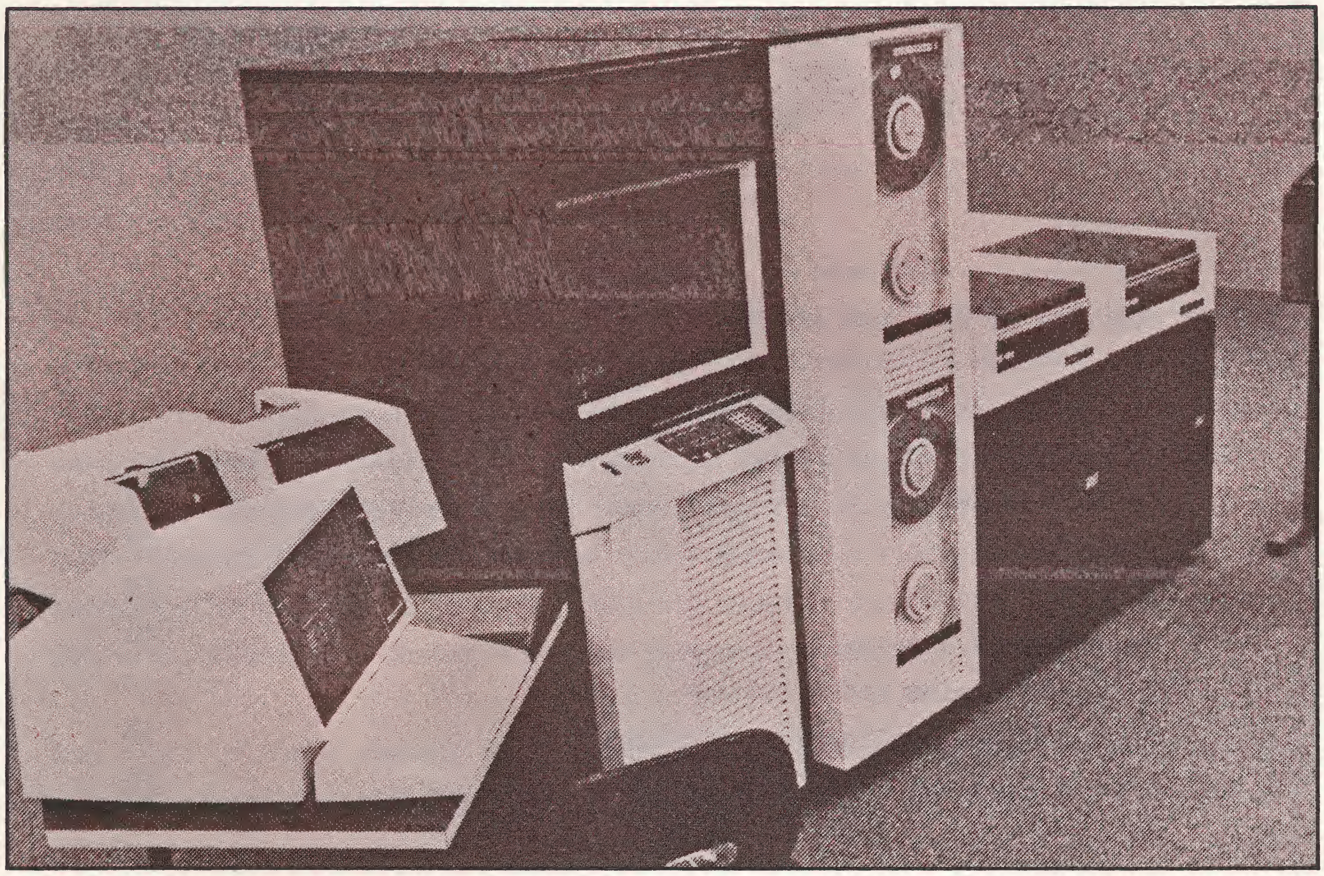

(System pictured: The more powerful Ultimate Model 5303)

In This Issue:

The ULTIMATE A1

ULTIMATE A1: BENCHMARK REPORT

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PREFACE

Our eleventh report in this series of BENCHMARK REPORTS on multi-user systems in the $25,000 to $50,000 price range covers the Ultimate A1. The purpose of these reports is to provide comparative information which will aid users in selecting from among the many alternative computing systems available--a service which is simply unavailable from any other independent source.

As we "come down the home stretch" now in this series of reports (one machine left to cover), we begin to reflect on all the systems we've seen. Each has had features and capabilities that can make it "just right" for many users. Though there is plenty of information available from the manufacturers regarding what makes their system the "best," much of it is often highly technical and difficult to understand. Conversely, there are also plenty of colorful brochures highlighting each system's advantages. Yet, in all of this, the user still finds it very difficult to determine the "real life" implications of the manufacturer's claims.

We feel these BENCHMARK REPORTS integrate all of this information and help the prospective computer user more easily compare alternative systems. This function of providing an overall picture of a machine and comparative performance results looms especially important in this report on the Ultimate A1. Using operating systems that are nearly identical, the A1 and the Microdata Series 4000 (covered in report No. 8) are often compared. Using these reports, our readers will be able to compare these two similar systems feature to feature--all with information presented by an <u>independent</u> source.

The heart of these reports is the results of running three benchmark programs on each system under study. Two of the programs are identical to those found in the Series 1 and Series 2 reports and provide comparability with the single-user systems covered there. The third is a multi-terminal order-entry program specifically designed to measure degradation in response time as terminals are added to the system. In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages available, operating system, utility and application programs, and overall ease of use. This information is based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Ultimate Al as configured for our tests consisted of the 4304 CPU, 128 kilobytes of central memory, an 80 megabyte fixed/16 megabyte removable disk drive, a 150 line-per-minute printer, an Ultimate CRT, eight serial ports (including a serial printer port), and Ultimate system software. Total price of the system was $50,645. A seven terminal price would be $55,415.

- The Ultimate Al's timings were the fastest we've observed to date on the order-entry benchmark. The CPU-Intensive timing though, was one of the slowest we've seen.
- The Al and the Microdata Series 4000 (evaluated in an earlier report) are "look-a-likes." Based on the same operating system originally developed by Pick Computer Works, these systems appear extremely similar from an end-user perspective.
- Ultimate systems are implemented on Honeywell hardware. Ultimate feels this gives their system a clear advantage over their competition based on Honeywell's reputation for state-of-the-art hardware. Some features of the hardware include a writeable control store which contains the operating system microcode (as opposed to PROM which cannot be written to by the system) and a potential for up to two megabytes of main memory.
- The Ultimate Al (and all Ultimate systems) is a microcoded, virtual memory machine. The microcoded firmware allows optimization of those instructions necessary for the virtual memory/database orientation of the machine. As a virtual memory system, the Al addresses all of the virtual memory (disk) as if it were part of main memory. Using a technique called paging, the operating system reads pages (or frames) of programs or data into memory which are then executed or manipulated. As a result, the effective size of program or data files is "virtually" unlimited.
- Ultimate systems range from the Al we tested (maximum configuration of 256K, 80/16MB, and seven CRT's) to the E model (up to 2MB main memory, 2GB disk, and 128 CRT's). All Ultimate software is compatible throughout this line.
- Ultimate users contacted in our survey were pleased with the system software, particularly the data retrieval language RECALL. Far less satisfaction was expressed with system reliability and service/support. At least half of those we spoke to had experienced hardware problems of some kind, while the other half were often "just satisfied."

One of the most expensive systems in this series of reports, the Ultimate Al was also the best performer in our order-entry benchmark. Though many of the users we interviewed had experienced difficulties, they were generally satisfied with their Ultimate system and considered it a powerful business tool.

BENCHMARK REPORT

SYSTEM: Ultimate A1

PRICE AS TESTED: $50,645

SPEED TESTS

Benchmark Number		
	CPU INTENSIVE	
A-4	N = 3000	123.7 seconds
	I/O INTENSIVE	
B-4	N = 3000	116.7 seconds

"REAL LIFE" PROBLEMS

Benchmark Number	**ORDER ENTRY**	
D-1	2 terminals	1.4 seconds
D-2	4 terminals	1.4 seconds
D-3	6 terminals	1.5 seconds
D-4	8 terminals	1.5 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program	Order Entry Program
E-1	2 terminals . .	126.4 seconds	1.6 seconds
E-2	4 terminals . .	130.3 seconds	1.7 seconds
E-3	6 terminals . .	135.3 seconds	1.9 seconds
E-4	8 terminals . .	*	*

Note: Order-Entry Program times represent average processing time per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

*With a printer in use, the maximum number of terminals that can be run on the Ultimate A1 is seven.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Ultimate and requested their assistance in benchmarking the A1. We requested that the total system be priced in the $25,000 to $50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 limit, we advised Ultimate that we would report the cost overrun, but would continue to benchmark the system using up to eight terminals.

Ultimate provided us with an A1 at their facility in Clark, New Jersey. The system consisted of a 4303 CPU, 128 kilobytes of EDAC memory, an 80 megabyte fixed/16 megabyte removable disk drive, a 150 line-per-minute Printronix printer, an Ultimate CRT, eight total serial ports, and the system software which includes Ultimate's BASIC and RECALL languages. Total system price as tested was $50,645. Ultimate also provided on-site technical support during the benchmark process.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the A1) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and Series 2 reports).

Benchmarking the Ultimate A1

A single day was all that was required to benchmark the A1. Upon arrival, we set up our equipment, and established communications with the A1. Interestingly, during our "dry run" to test the order-entry program, we experienced a communications "glitch" in exactly the same manner as we experienced on the Microdata system. The problem was easily corrected, though we are unable to explain why it occurs. We then proceeded to routinely complete the benchmark testing.

Our Observations

The Ultimate A1 is a microprogrammed machine built on Honeywell hardware. Microcoded firmware (software stored in a 2K by 64-bit writeable control store) contains the system's virtual memory manager, multi-user operating system, and some special data management instructions. The writeable nature of control store (as opposed to a set of PROM's or Programmable Read-Only Memory) allows Ultimate to provide its users with system upgrades on secondary storage media (tape or cartridge disk) rather than requiring removal/replacement of PROM boards.

A virtual memory system (further explained in the Detail Pages) requires relatively more system "overhead" than other systems. For this reason, this type of approach is normally found on larger, more powerful systems. To overcome the added demands of a virtual memory operating system and still provide the performance users demand, the Ultimate system provides microcoded firmware (as described above) and the potential for up to two megabytes of main memory. The microcoded firmware allows optimization of those instructions and procedures necessary for the virtual memory/database orientation of the A1 while the large memory potential allows a user to minimize "thrashing" (page swapping) and its associated performance penalty. It is clear from our test results, that Ultimate has designed a system that maximizes performance using these techniques.

To a programmer or user unfamiliar with a virtual memory machine, some "adjustment" is required to the logical picture of the computer. In a virtual memory system, memory is an abstract concept. A logical program or data segment may reside in central memory or disk storage and the operating system must "map" the physical location into the logical location. What we normally

view as main memory should now really be viewed as a high-speed cache memory or a place where the CPU views and manipulates data and instructions. What we normally consider secondary storage accesses (i.e., disk reads) are simply a by-product of a particular data or instruction address.

This "fuzziness" of a virtual machine's disk storage and main memory was pointedly demonstrated to us when we ran our I/O-Intensive program. The intent of this program is to "pound the disk" or cause the system to make a specified number of disk accesses. When our host "pulled the plug" on the disk drive, and the program continued to run, it was clear "I/O-Intensive" has a different meaning on a virtual machine. Without getting too technical, this was a result of the situation where memory was large enough that all addresses generated to store the output of the program were located in main memory, thus requiring no access to disk. Had other programs been vying for main memory, or had the file been much larger, then eventually the system would have had to begin reading from and writing to the disk. Thus it is clear that on a virtual machine, the amount of disk access taking place in an I/O-intensive program is extremely dependent on the context or environment in which the program resides and is executing. However, this problem exists to a lesser extent on most systems we have tested, where buffer size will affect I/O-intensive performance.

The operating system employed by Ultimate is based on a system originally developed by Pick Software Works. This system is extremely "friendly" to users and with the RECALL language, provides the novice user with easy access to data and reports. The version of Release 10 of Ultimate's operating system we tested was unreleased at the time of our benchmarks, but should be available when this report is published.

The times we observed on the A1 are impressive. To obtain the eighth port in our eight-port tests, we disconnected the system printer and used that serial port (the SPOOLer took care of all printer output). As an aside, the compatibility between the Microdata system we tested and this Ultimate system was clearly evidenced by the order-entry benchmark program. The source codes used on each system were line-by-line duplicates.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-Intensive job
- An I/O-Intensive Job

"Real Life" Problems

- An Order-Entry program run with varying numbers of terminals
- An Order-Entry program run with varying numbers of terminals and background execution of the CPU-Intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide easy comparison with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-4	Results:	N = 3000	123.7 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	116.7 seconds

"Real Life" Problems

This program is based upon an order-entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

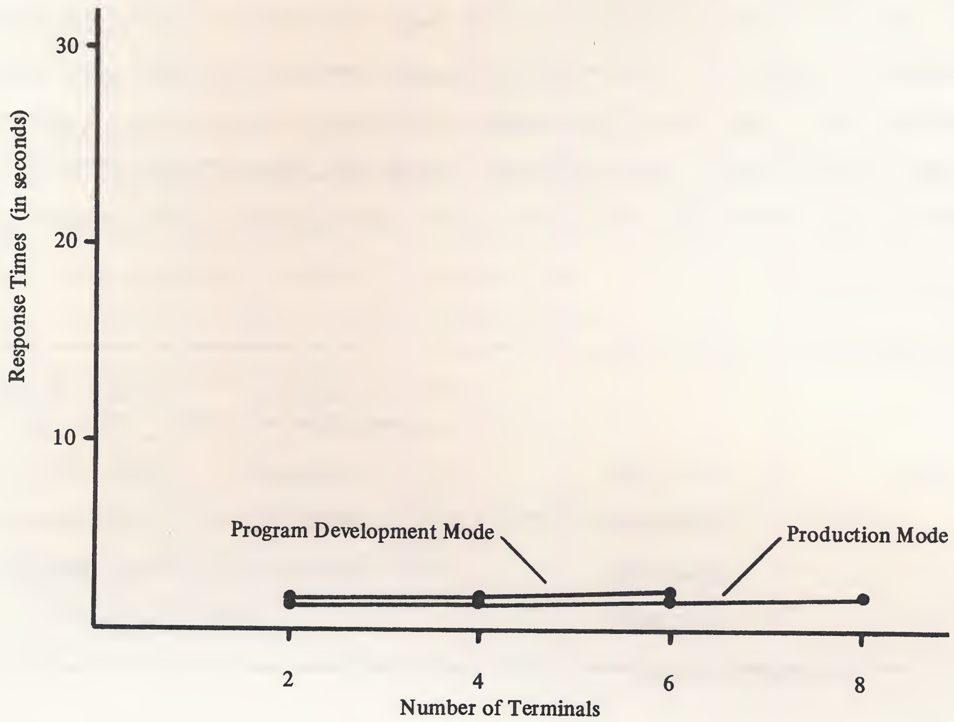
Order-Entry Run in Production Mode

The order-entry program was run with 2, 4, 6 and 8 terminals and no other programs running on the system. This would be a typical production mode application.

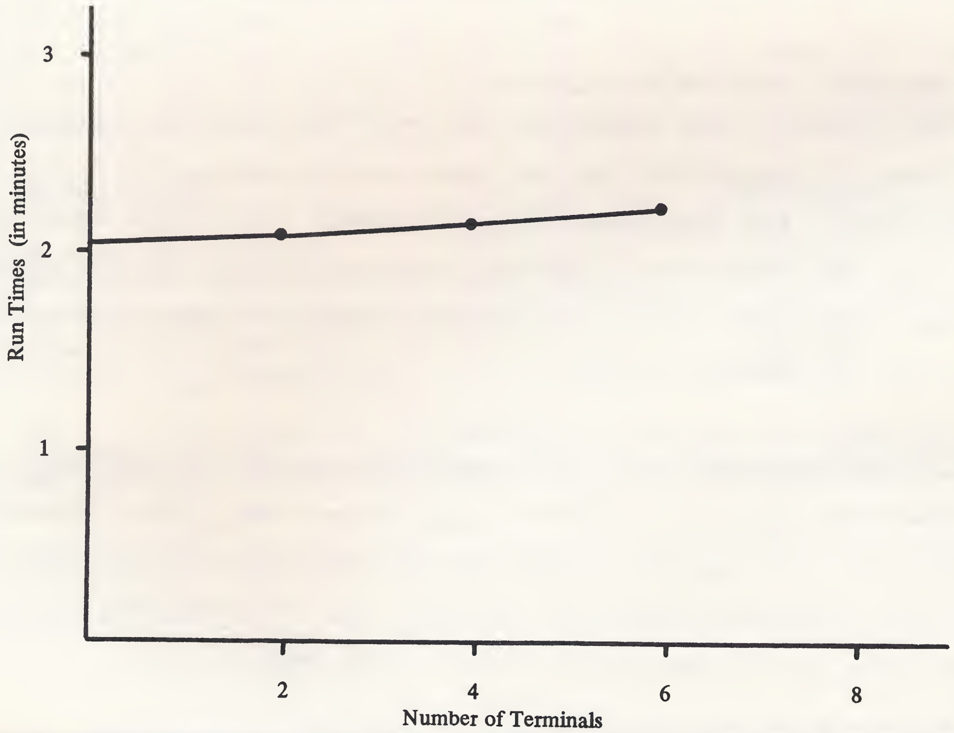
D-1	Results:	2 terminals	1.4 seconds
D-2		4 terminals	1.4 seconds
D-3		6 terminals	1.5 seconds
D-4		8 terminals	1.5 seconds

Note: *By disconnecting the printer, we obtained the eighth port for this test.*

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



Order-Entry Run With Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-Intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-Intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	126.4 seconds	1.6 seconds
E-2		4 terminals	130.3 seconds	1.7 seconds
E-3		6 terminals	135.3 seconds	1.9 seconds
E-4		8 terminals	*	*

Comment: *To run the eight port "development" mode test requires 9 ports (one for the CPU-Intensive program and eight for the order-entry). The maximum number of terminals that can be run on the Ultimate A1 is eight (using the special printer port as the eighth and leaving the system with no physical printer attached).*

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for 2, 4, 6 and 8 terminals without the background program running (production mode) and for 2, 4 and 6 terminals with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-Intensive job.

The Ultimate Al's performance on our order-entry benchmark was extremely good. Its timings range from about 13 to 1000 percent faster than other times we've observed to date (13 to 40 percent faster than the Microdata Series 4000 we tested). With its database orientation, however, the CPU-Intensive timings for the Al were among the slowest of all those we've seen.

SYSTEM AS TESTED: ULTIMATE A1

Costs

Ultimate A1 Base System Configuration	$29,750
• 4304 CPU	
• 5-slot chassis in 30" cabinet	
• 64K EDAC HDMOS memory and controller	
• 2K Extended Control Store	
• 16/16MB disk drive and controller	
• 3 open ports, serial printer port	
• Ultimate Release 10 Operating System	
80/16MB disk substitution	$ 5,000
Add 64K EDAC HDMOS memory with parity	$ 6,000
16MB disk pack	$ 350
150 lpm Printronix printer (with pedestal and paper catcher)	$ 6,250
Two 2-port activators	$ 2,500
CRT (Ultimate label)	$ 795
Total System	$50,645

Our Observations

Up to seven total terminals may be attached to the Ultimate A1 (the eighth port is normally used as a serial printer port, though in our tests we used it as a terminal port). We have priced in the Ultimate terminals at $795 each. The 2-port activators need only be purchased, of course, if the three open ports available with the base configuration are insufficient.

Configuration	Total Price
System with one terminal	$48,145
System with two terminals	$48,940
System with four terminals	$51,780
System with six terminals	$54,620
System with seven terminals	$55,415

All prices given above include Ultimate's Release 10. This system software release includes RECALL, BASIC, PROC, TCL, EDITOR and RUNOFF.

Summary of Equipment and Features

- The Ultimate A1 (and all models up to the E model) uses the 4303 CPU which is designed and manufactured by Honeywell. This 16-bit processor is capable of directly addressing up to two million bytes of memory. Through the use of 16 virtual address registers, over two billion bytes of "virtual" memory may be addressed. The CPU requires one slot in the system bus (Megabus).
- The A1 base system is equipped with 64K of EDAC (Error Detecting and Correcting) High Density MOS memory. An additional 64K of memory costs $11,000 with controller (up to 256K per controller) and $6,000 without. Memory can also be bought in 256K increments for $20,000. Two million bytes of memory would occupy only eight slots in the Megabus.
- The A1 system comes with a 5-slot chassis in a 30" cabinet. All other Ultimate systems (from the B to the E) come with a 10-slot chassis in a 60" cabinet. A 4-slot expansion chassis with power supply can be purchased for $7,000, and a 9-slot for $9,500 (maximum configuration is 23 slots).
- All Ultimate models are software compatible. All employ the 4303 CPU except for the E model which uses the 5303. This CPU uses the same instruction set as the 4303, but executes more quickly through the inclusion of a 4K cache memory.

Our Observations

The hardware used by Ultimate is all totally unmodified Honeywell hardware. In fact, if the user wished to purchase Honeywell's GCOS operating system, the A1 could be run as an "Ultimate" or as a "Honeywell." Ultimate believes that using Honeywell hardware gives them a tremendous advantage over their competition due to Honeywell's reputation in the industry for state-of-the-art equipment.

Users' feelings about the speed and capability of their system were quite varied, as the comments below point out. There did seem to be some consensus that more memory would help their performance problems. We've found that insufficient memory is often a problem for virtual memory system users (see our comments on page 14 of the Microdata report).

User Comments

- *If we have three or more terminals going, it can take 3 or 4 minutes for access, while a customer is waiting.*
- *We could make it faster with more memory.*
- *Doesn't degrade very much when all seven CRT's are going, just when someone is doing a very long process on it.*
- *It degrades for each terminal (up to 4) that we add, no matter what the application. Though this does hamper us somewhat, all in all, it's better than we had.*

STORAGE DEVICES

Summary of Equipment and Features

- Included in the base system configuration of the A1 is a 16 megabyte fixed/16 megabyte removable cartridge disk drive. When purchased separately in a freestanding cabinet, this system costs $15,000. A 16MB disk pack is priced at $350.

- The 80/16MB substitution as used in our tests costs $5,000 (priced at $18,000 when purchased separately without controller). Other drives include a 75MB drive ($19,000 without controller) and a 288MB drive ($31,000 without controller). Each disk controller occupies one Megabus slot and will handle four disk drives.

- Tape drives are also available for Ultimate systems. All systems from the B1 on up include a 800 BPI, 45 IPS tape drive in the base system. A 9-track, 800 BPI, 45 IPS drive plus controller costs $21,000 when purchased separately.

Our Observations

The two fixed/removable drives are CMD's or Cartridge Module Discs. These units can be rack mounted in the processor cabinet. The larger drives are disk pack drives and are mounted in their own freestanding cabinet. The 75MB disk pack costs $550 while the 288MB pack costs $1,350.

The users we surveyed seemed satisfied with their storage devices and generally rated their drives as reliable.

User Comments

- *The 80/16 disk drive is more than sufficient for our needs. We're only using about half of it.*

- *The 16/16 is enough for now, but we might need more once we get involved in additional functions.*

- *No problems with the tape drive.*

- *I would like Ultimate to come out with a better way to do backups. Tapes are awfully cumbersome.*

Summary of Equipment and Features

- The Ultimate label CRT ($795) is a non-intelligent terminal with standard typewriter keyboard layout and separate numeric pad. Other CRT's include ADDS Models 25, 40, and 60 (priced at $995, $1,650 and $2,150, respectively). A Honeywell CRT is also offered ($2,000).
- Printers from the A1 and B models include a 150 cps printer ($3,500), a 150 lpm and 300 lpm serial printers ($6,000 and $9,500). System printers (which require a printer controller) include three Printronix printers (150 lpm for $5,000, 300 lpm for $9,000, and 600 lpm for $12,000) and three Honeywell printers (300 lpm for $11,500, 600 lpm for $19,000, and 900 lpm for $23,000).
- A dual line bisynchronous communications board is available for $3,500. This offers IBM 2780/3780 protocols.

Our Observations

To run the 8-port order-entry test, we used the serial printer port as our eighth port. The system spooler took each terminal's printer output and saved it as a "hold file" which we could later dump to the printer.

User comments on the peripherals were generally favorable with the exception of the ADDS Model 25. The Printronix line printers received praise from most of the users we spoke to in our survey.

User Comments

- *The Printronix line printer we have is very good.*
- *The Model 25's keyboards had to be replaced--they couldn't take the constant pounding.*
- *The Model 25's and 40's do not have much "polish." I'd like to see a baud switch and dimmer control.*
- *At first I was very annoyed with the Model 40. I basically had to take it by default because I needed a CRT with a detachable keyboard, but Ultimate never got around to telling me which ones were compatible (besides the 40).*
- *We had terrible trouble with the Printronix 150 lpm printer for quite some time. It's running fine now and is in fact the most stable and reliable part of our system.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- Included in the Ultimate A1 package is the Release 10 virtual memory operating system and a variety of database management software including RECALL, BASIC, PROC, EDITOR, ASSEMBLY, and various file maintenance and other utilities.
- Nearly all Ultimate system software is invoked directly from the Terminal Control Language (TCL) which provides the primary interface between the user and the various processors and utilities.

Our Observations

If this section of our report (and the next) appear very similar to our earlier report in this series on the Microdata Series 4000, it is because the A1 and the Series 4000 are very similar in this area. In fact, if a user sat down in front of an "unmarked" terminal and used one of these systems, differentiation between systems on a user/system interaction basis would be nearly impossible. Though subtle differences do exist, both systems are based on operating system software originally obtained from Pick Computer Works. The operating systems are implemented differently, but appear similar due to their common "ancestry."

The Ultimate A1 is a virtual memory machine. The A1's virtual memory (which is disk) is directly addressable as if it were part of main memory. All data files, user and system programs, etc., are resident in virtual memory, while the operating monitor (the executive) is resident in main memory (it uses about 8K bytes). From the programmer or user standpoint, file size is "virtually" unlimited (limited only by the available space on the disk).

Each file or program is divided up into 512 byte frames or pages. Using a technique called paging, one frame at a time may be read into main memory and executed. When the program addresses a location which is not on the resident frame, the new frame is read (or paged) into memory and execution is resumed. Each process (or terminal) requires a minimum of one frame in main memory to be actively executing (a user's program may be temporarily written out to disk or "swapped" if memory is required by other programs, but when the program is in main memory, it requires at least one frame). If memory is available, the system will allocate more to a user as needed and thus reduce the amount of paging needed to run the program.

The A1 organizes files in a hierarchical structure so that files at one level point to multiple files at a lower level. The highest level file is the system dictionary. This dictionary (of which there is only one on a system) contains the list of valid users of the system, system utility and accounting files, and pointers to each user's master dictionary (the next level). The master dictionary for a user contains all file names and procedures accessible by that user and attributes which describe the structure of the information in the user's lower level dictionaries. Each master dictionary may point to a number of dictionary level files which describe the structure of the data in the associated data files. Each data file is described by one dictionary level file.

Within each data file there may be any number of records which can consist of one or more variable length fields. Each field in turn, may consist of any number of variable length values which may consist of any number of variable length subvalues. Records, fields, values, and subvalues are separated by special markers inserted by the system. The only size limit is a maximum record length of 32,267 bytes.

The data files may be accessed at the file-record-field level by the EDITOR and COPY processors. These processors (or utilities) do not distinguish among the fields as described in the data dictionaries, while the RECALL and BASIC processors do use the data dictionaries. These dictionaries define the nature of the information stored in each of the fields and permit access by field name and specify internal and external data formats.

Communication with the Ultimate system is accomplished using Terminal Control Language (TCL). With TCL, the user may invoke utilities, processors, and programs by entering simple commands (called verbs). Any particular user may have an individualized vocabulary be defining synonyms for the system verbs. In addition, by entering or deleting verbs from a user's master dictionary, each user's capabilities on the system may be expanded or contracted without affecting any other users.

Through the use of the PROC processor, a user may store a complex sequence of operations which can later be invoked by a single word command. With features that include argument passing, terminal prompting, and branching, PROC's provide a useful and powerful tool for the user. Unfortunately, in our opinion, we felt the PROC "language" was overly complex as compared to similar features on other machines we've tested. We feel some simplification in this area would make this an even more useful tool.

The RUNOFF processor on the Ultimate system is a word processing utility that formats information through commands stored in the text to be processed. Features of RUNOFF include margin justification and automatic page numbering, chapter and section numbering, and table of contents and index generation.

User Comments

- *We like PROC very much. It's one of the unique things on the system.*
- *EDITOR is pretty good. It's been upgraded and that's made it better.*
- *We upgraded to a new release of the operating system and that caused problems with our programs. Ultimate didn't tell us what problems to expect.*
- *We could use the utilities and languages more if we had better documentation and training.*

LANGUAGES AND APPLICATION PACKAGES

Summary of Features

- The Ultimate A1 system software includes the BASIC language, an enhanced version of standard Dartmouth BASIC, and RECALL, a data retrieval/report generator language.
- Application packages are supplied by Ultimate dealers and not Ultimate itself. The users we spoke to reported a large variety of packages available.

Our Observations

Ultimate's BASIC is a highly enhanced version of BASIC. It combines some of the best features of BASIC (variable length string variables, multiple statements on a line, etc.) with many of the nicest features of FORTRAN (such as external subroutine calls, COMMON variable storage, etc.).

To retrieve data or generate reports, the A1 user employs RECALL, the Ultimate retrieval language. An easy-to-use language, RECALL statements are entered at the TCL level and consist of a relatively freeform sentence that begins with a verb indicating the action to be taken, the name of the file to be accessed, any qualifiers on the selection, and then the list of attributes which are to be printed on the report. RECALL uses the information in the user's master dictionary to format the data, produce headings, etc. Some of the actions that can be taken include lists, sorts, counts or sums, and selections.

The users we surveyed were generally very pleased with Ultimate software, particularly RECALL. They were often much less satisfied with application software obtained from their dealer.

User Comments

- *We've had some software problems, and though our dealer is helpful, it takes him a long time.*
- *RECALL is great. It helps ease the day-to-day data searches we need to make.*
- *The BASIC is not spectacular, though it's all right. I'd like to see Pascal and COBOL.*
- *With RECALL, we can do almost anything we want without writing a program--as long as the data is there.*
- *RECALL is a lovely tool, although it's been a burden because we've had no instruction.*

Summary of Features

- As of April 30, 1981, Ultimate had 44 dealers in its dealer network who sell the Ultimate systems to end-users and provide application software and service. Ultimate provides training and support to these dealers covering the operating system and hardware.

- Though the user obtains a maintenance contract from Ultimate, hardware maintenance is performed by Honeywell technicians while system software problems are handled by Ultimate. If the user can clearly define the problem as hardware related (e.g., smoke coming out of the disk drive), they are encouraged to call Honeywell directly. If the problem is less obvious, users may contact Ultimate personnel who will help "track down" the problem. As Ultimate's relationship with Honeywell has grown, Honeywell has begun providing personnel who work exclusively with the Ultimate system and will be able to provide system software support as well as hardware support.

Our Observations

In this area of hardware and software reliability, service, and support, the users we surveyed expressed the most dissatisfaction. At least half experienced some types of problems while the others were "just satisfied."

User Comments

- *Had it a year with no problems and good service.*

- *We've been down three days now. Service of late has not been too good and is getting worse. Honeywell is not returning our calls, not telling us the status of things.*

- *We've had a lot of hardware problems, right now we're in the middle of a one week breakdown. Honeywell's service is lacking. Parts usually are not available, so we have to wait.*

- *Nothing out of the ordinary has happened. Our service is okay from three different sources.*

- *I'm leery of the company. I wish Honeywell would buy them so we'd be more secure. They're not organized very well because they are growing so fast. The dealers we're familiar with are not knowledgeable and can't optimize the system.*

- *Documentation is not too good. It's written by someone who assumes you know a lot about computers.*

- *Training could have been better. If I had to do it over again, I would have had someone come here to train our personnel.*

SUMMARY OF USER COMMENTS

Using names supplied by the Ultimate Corporation, we interviewed users of the Ultimate A1 system (11 users) and the B/B1 systems (4 users). A variety of businesses were using the Ultimate for financial reporting, standard accounting procedures, and inventory control. Most had purchased the Ultimate as a turn-key system or purchased software packages/programs from a third party, while a few were doing programs and modifications in-house. Before buying the Ultimate, these firms had evaluated many other computer systems on the market, and cited software as the main reason for choosing the Ultimate, along with price and Honeywell service and maintenance. They had owned the Ultimate from two months to a year and a half.

The standard hardware configuration was 64K bytes of main memory and 16/16 (fixed/removable) or 80/16 megabytes of disk storage. Several users had the maximum seven terminals; others had from two to five CRT's. These were largely ADDS Model 25's, Model 40's, Model 60's, and some Honeywell terminals. 150 lpm to 300 lpm Printronix line printers were most widely used, with other printers including Honeywell, Pertec, and DEC. Storage capacity was viewed as generally adequate, though several firms said they would eventually need more. Central memory sizes were also satisfactory, again with some intending to upgrade from 64K.

Hardware reliability and service was a "mixed bag" for most of the users we spoke to. Generally, these users had three (or more) different sources to contend with, including printer suppliers, terminal suppliers, application suppliers, and Ultimate/Honeywell system suppliers. Four of the users said the ADDS Model 25's had defective keyboards which had to be replaced. Another said the Model 25's and 40's were simply not refined and lacked "polish." Everyone liked their Printronix printers, but a user with a 150 lpm model said it was too slow for the system.

Most of the service calls and downtime reported by the users were caused by faulty peripherals, though nearly a third had trouble with the computer itself. Several users had "head crashes," one user was being hampered by power surges, and two users mentioned problems with "cold starting" the system.

Overall, the service for the peripherals was felt to be adequate. However, some users were totally dissatisfied with the service they were receiving. About half were happy with Honeywell's service, though one user noted that they did not do preventative maintenance. On the other hand, others commented that Honeywell service was "lacking" and "going downhill."

At least half of the users we spoke to reported problems with their application programs, but were generally pleased with the support they received from their programmers. Some people were unhappy though, because they were interested in some application software developed by dealers who would only sell the software as part of a complete system. The consensus about the outstanding feature of the Ultimate was RECALL. As one user summed it up, "We can do almost anything we want to without writing a program." Ultimate's BASIC was also generally well liked, with most agreeing that it is "good, but not spectacular."

Users were divided regarding their feelings about Ultimate's documentation. Many said it was nearly "unuseable" because it was too technical and assumed to much prior knowledge. Several users felt they were not benefiting from the system as much as they should due to the poor documentation. Training, or lack of training, was another sore spot for a number of users. Several said the training was good, but the majority thought it was too minimal. One user commented that "Ultimate leaves too much to the dealer."

All fifteen users interviewed said system response time degraded when all terminals were running. For the most part though, they did not lay the blame on Ultimate. One user felt his application package was causing the problem and that it was "not Ultimate's fault." Another said "the new releases are making it faster" and that while "system degradation is noticeable, it's not critical." In contrast, one user said that system speed was very, very good and could be made faster by upgrading main memory.

Even though it slowed down, printers and CRT's malfunctioned, and the documentation was regarded as "weak," a clear majority of the users we surveyed were nonetheless, satisfied with their Ultimate system. This view was illustrated by one user's comment: "I don't have anything against the Ultimate system--it's just that we got caught with the wrong kind of peripherals." Unfortunately, in stark contrast, two of the fifteen users we spoke to were extremely unhappy with their system.

CONCLUSIONS

The Ultimate Al system is based on Honeywell computing hardware, and Ultimate's version of the Pick operating system, along with whatever non-intelligent terminals and printers the user chooses. A maximum of eight ports are available on the Al, with one usually reserved for the printer.

The Pick system is designed to optimize data storage and retrieval, and to provide the utilities which facilitate user interaction with the machine. Each data file is described by one or more dictionaries which identifies keys, labels, output formats, etc. Combined with the RECALL utility, the user can easily select records from the file and generate reports.

The Ultimate utilizes virtual memory techniques, where the system maps from the programmers logical view of the program to the physical location in memory or on disk. While this relieves the programmer from concerns about program size, in a poorly designed program the system spends so much time bringing program pages into memory from the disk that performance significantly degrades with just a few users. While additional memory will reduce this problem, we also believe that "tuning the system," by appropriate program design, timeslicing, page allocation, etc., are more critical in a virtual memory system.

Key components of the Pick system are microcoded and stored in a very fast writeable control store on the Ultimate. Because it is writeable, as opposed to read only, no hardware changes are required for system upgrade, only a new system disk.

Users were generally happy with the capabilities of the system, particularly the RECALL system for generating reports. They were less than happy with reliability of the equipment, and service/support. Because the hardware is supported by Honeywell, the operating system by Ultimate, and peripherals by others, we would anticipate coordination problems. However, as Ultimate becomes a larger factor in Honeywell's sales, we might expect this problem to decline.

This is our second look at a Pick based system (the first was Microdata) and we must say we are impressed, particularly with the database orientation, and the RECALL data selection and report generation utility. The system is very fast on our order-entry program. For business data-oriented applications, the Ultimate is a serious contender.

BENCHMARK REPORT	An association to help the computer user make informed decisions. . .	ASSOCIATION OF COMPUTER USERS
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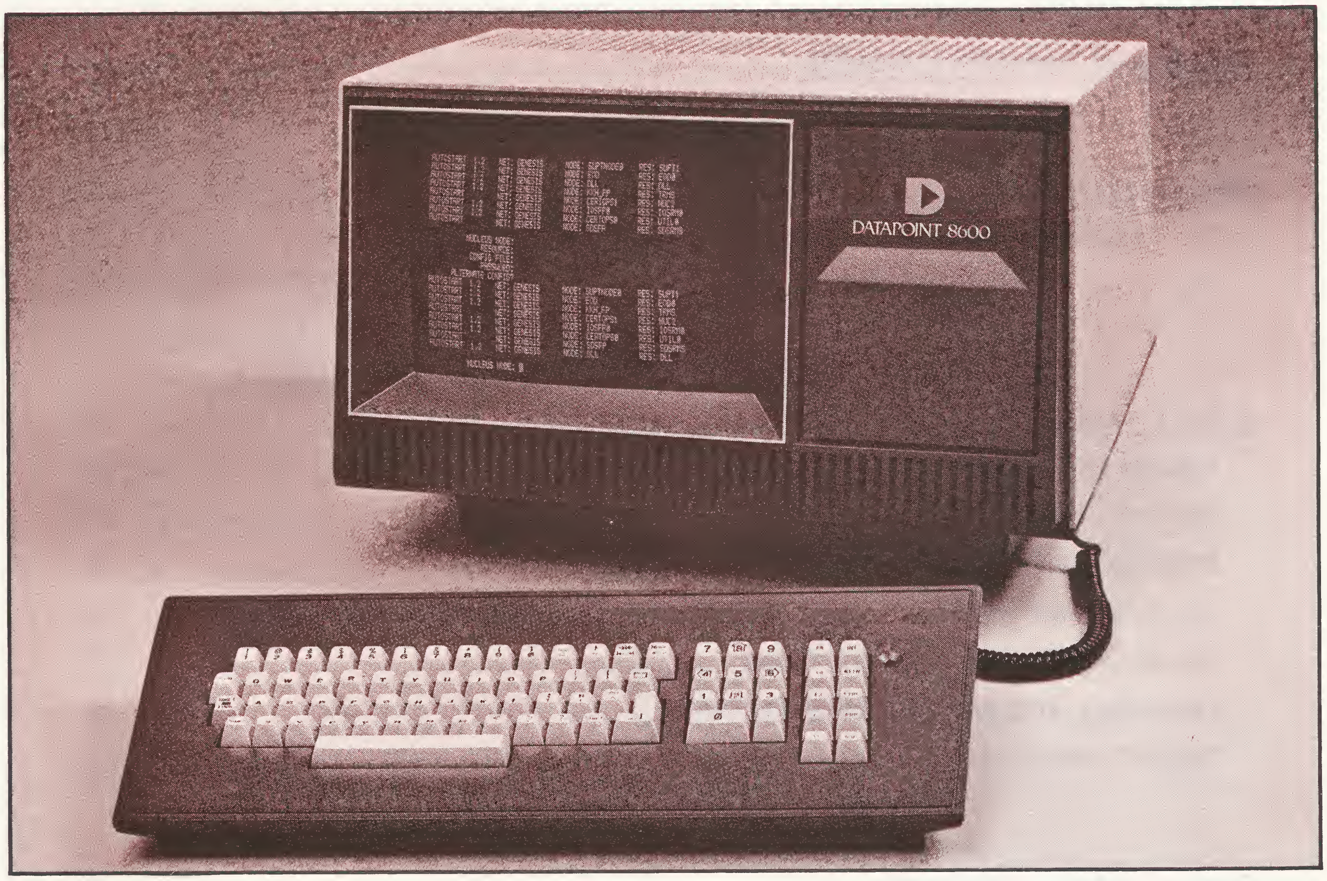

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The DATAPOINT 8600

DATAPOINT 8600: BENCHMARK REPORT

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PREFACE

Our twelfth and final report in this series of BENCHMARK REPORTS on multi-user systems in the $25,000 to $50,000 price range covers the Datapoint 8600. The purpose of these reports is to provide comparative information which will aid users in selecting from the many alternative computing systems available--a service which is simply unavailable from any other independent source.

Over the past year-and-a-half we've seen and evaluated twelve different multi-user minicomputer systems. We've reported on low priced systems and expensive systems, systems produced by large, well known manufacturers and systems from small, lesser known producers. We've seen a variety of software, some of it "terrifying" from a novice user's standpoint, and some extremely "user-friendly." We've completed our full benchmark procedures in as little as eight hours and as long as two months. And of course, we've met many friendly and competent people without whose help this series of reports would have been difficult to produce.

Through it all, we must add, we've liked some features on every machine we've examined--each has had capabilities that would make it "just right" for some users. Though there is plenty of information available from the manufacturers regarding what makes their system "best," much of it is often highly technical and difficult to understand. Conversely, there are also plenty of colorful brochures highlighting each system's advantages, yet lacking in technical detail. We feel these BENCHMARK REPORTS integrate all of this information and help the prospective user more easily compare and choose from among the many alternatives.

The heart of these reports is the results of running three benchmark programs on each system under study. Two of the programs are identical to those found in the Series 1 and Series 2 reports and provide comparability with the single-user systems covered there. The third is a multi-terminal order-entry program specifically designed by the Business Research Division staff to measure degradation in system response time as terminals are added to the system. In addition to the benchmark results, these reports contain information on the alternative configurations which can be assembled, storage capacities, input and output capabilities, languages, operating system, utility and application programs, and overall ease of use. This information is based on our own observations made during the benchmark process, discussions with vendors, and comments taken from our survey of users.

EXECUTIVE SUMMARY

The Datapoint 8600 system as configured for our tests consisted of a Datapoint 8630 system (an 8602 processor with 128 kilobytes of main memory, a 20-megabyte hard disk, and a 20-megabyte cartridge tape drive), an additional 128 kilobytes of main memory for the 8602 processor, two Multiport Communication Adapters (four ports each), an 8601 applications processor with 128 kilobytes of main memory, and a 160 character-per-second matrix printer. Total system price including all Datapoint software was $48,175. An eight-user configuration would be $59,545.

- The 8600 system we tested employed the RMS-based (Resource Management System) version of Datapoint's ARC (Attached Resource Computer) local network. We found this system to offer impressive capabilities in terms of resource sharing and distributed processing. Users throughout an ARC network can use software functions (application programs, utilities, etc.) and hardware (printers, disks, etc.) simply and easily, without regard to the geographical location of the function.

- Other advantages of the ARC network center around the modular growth concept and the ability to place processing power where it is needed. As a user's computing needs grow, the Datapoint system can grow incrementally by adding processors and peripherals when and where needed. Hardware need not be replaced, but merely added to the network with a simple coaxial cable connection.

- All Datapoint software is included in the system price. Our order-entry benchmark program was written in the DATABUS language. A simple "assembly-like" language, we felt that some structured programming statements would make it more useful.

- The Datapoint 8600 timings placed it in the middle of the timings we've tested previously. It is interesting to note that because the CPU-Intensive background program was in a separate processor from the order-entry program (the 8601), there was no interaction/interference between programs. As a result, the production mode and development mode timings were exactly the same.

- The Datapoint 8600 series of computers is available in four different configurations ranging from the 8601 processor with no peripherals to the 8630 which is an 8602 processor with a 20-megabyte disk drive and 20-megabyte cartridge tape drive.

- The users we spoke to in our survey were generally pleased with their Datapoint equipment, especially Datapoint support. They cited modularity, versatility, and previous experience with Datapoint as their main reasons for choosing Datapoint equipment.

With local networking and a modular approach, the Datapoint 8600 can grow with a business' data processing needs and is certainly a system worth considering.

BENCHMARK REPORT

SYSTEM: Datapoint 8600

PRICE AS TESTED: $48,175

SPEED TESTS

Benchmark Number	CPU INTENSIVE*	
A-8	N = 3000	57.4 seconds
	I/O INTENSIVE	
B-4	N = 3000	30.3 seconds

"REAL LIFE" PROBLEMS

Benchmark Number	ORDER ENTRY	
D-1	2 terminals	4.2 seconds
D-2	4 terminals	4.4 seconds
D-3	6 terminals	5.1 seconds
D-4	8 terminals	5.2 seconds

SIMULTANEOUS ORDER ENTRY AND CPU-INTENSIVE

		CPU-Intensive Program*	Order Entry Program
E-1	2 terminals . .	57.4 seconds	4.2 seconds
E-2	4 terminals . .	57.4 seconds	4.4 seconds
E-3	6 terminals . .	57.4 seconds	5.1 seconds
E-4	8 terminals . .	57.4 seconds	5.2 seconds

Note: Order Entry Program times represent average processing times per order entry transaction, each composed of approximately 12 lines of actual input. Thus, the average "terminal response time" per line would be approximately 1/12 the time shown.

*Normally, A-4 (a program with square and square root) timings are reported. Since the DATABUS language does not have root functions, A-8 (using only multiplication and division) timings are given.

THE BENCHMARK PROCESS

To begin the benchmark process, we contacted Datapoint and requested their assistance in benchmarking the 8600. We requested that the total system be priced in the $25,000 to $50,000 price range, and that this price include as many terminals as possible up to a maximum of eight. If the additional terminals caused the price to exceed the $50,000 limit, we advised Datapoint that we would report the cost overrun, but would continue to benchmark the system using up to eight terminals.

Datapoint provided us with an 8600 system at our offices in Boulder, Colorado. The system consisted of a Datapoint 8630 (8602 processor with 128 kilobytes of main memory and the 9301 disk subsystem containing a 20-megabyte hard disk drive and a 20-megabyte cartridge tape drive), an additional 128 kilobytes of main memory for the 8630, two Multiport Communication Adapters (each with four ports), an 8601 application processor with 128 kilobytes of main memory, and a 160 character-per-second matrix printer. This system, including all Datapoint software, is priced at $48,175. Datapoint also provided on-site technical support during the benchmark process.

The Remote Terminal Emulator

Execution of the order-entry system program and all response-time measurements are controlled by our Remote Terminal Emulator (RTE). The RTE system is composed of a driver computer, a North Star Horizon, and a driver program written by our staff. The RTE appears to the test computer (the 8600) as up to eight people sitting at eight standard terminals, all of whom are individually interacting with the order-entry program on the test computer. Our use of a computer to interact with the test computer is designed to eliminate the variability inherent in human operators, a variability which may often have exceeded the differences in processing speeds we are attempting to measure.

In addition to "conversing" with the test computer, the RTE also measures the time each terminal spends receiving input and sending output. These two times, subtracted from the total time each terminal is in use, yield the response or processing time of the test computer.

All I/O-Intensive and CPU-Intensive program timings were made using a stopwatch (as in our Series 1 and Series 2 reports).

Benchmarking the Datapoint 8600

Two full days were required to complete the benchmark testing of the Datapoint 8600. The first day was primarily spent resolving some stubborn communications problems between the 8600 and the RTE and also between the 8600 and the printer. The second day was spent resolving software problems, validating the operation of the order-entry benchmark program, and finally conducting the benchmark timings.

Our Observations

When viewed alone as a single machine, the Datapoint 8600 system is just another well designed, multi-user minicomputer. When viewed as part of the ARC (Attached Resource Computer) local network, the 8600 becomes more than just another minicomputer--it becomes part of a powerful and flexible computing system.

Acknowledged as a leader in local networking, Datapoint released the ARC local network in 1977. This initial version of ARC offered not just device-to-device data transfers, but also common file formats, limited hybrid operation with shared-logic and processor based workstations, multiple access to files without conflict, and extended geographical dispersion. With the release of the RMS (Resource Management System) operating system in 1980, additional capabilities became available including resource sharing throughout the entire network, geographical independence allowing worldwide networks, total functional independence, and support for all functions of the network using lower cost non-intelligent terminals.

What's the bottom-line of all this networking and distributed processing capability? In our discussions with Datapoint personnel, they emphasized the concept of easy modular growth. For instance, when that "n'th" user is added to a computing system and performance falls off (as we've seen happen in our benchmark tests), processing power can be enhanced simply by adding another processor to the network. It is not necessary to remove hardware and replace it with a more powerful system. As we saw in our benchmark tests, with the ARC system all that is needed to add another processor (the 8601 in our case) is a piece of coax cable. This processor/workstation can then use all functions of the system, and in our example, effectively double the processing power of the system (for an additional $7,500). With the modularity and flexibility of the system, a user can start with a small system and add power when and where it's needed.

The shared resource concept available through RMS can take some getting used to for those not familiar with local networking. What it boils down to is that with RMS, a user may access any function of the system no matter where that function resides. Thus a user at any workstation on an ARC network can (if given the appropriate permissions) access and use any software function on the network (like the Integrated Electronic Office Station or other applications) and any printer, disk, or other peripheral that is attached. Though these accesses can be made simple for the end-user, it does require some sophistication on the part of the system manager to set up the appropriate environment(s).

Our order-entry benchmark program was written in Datapoint's DATABUS programming language. Though touted as a simple and flexible business programming language, we felt that DATABUS was a bit too simple and rather bulky. Its structure is similar to a two-operand assembly language (label, operation code, and operands) and lacks any structured programming statements. While its structure is certainly simple, we feel it can only be "natural" for programmers whose first language was assembly. Nonetheless, in its favor DATABUS is easy to learn, compiles very quickly, executes efficiently, and offers good terminal I/O capabilities.

During our benchmark tests, the order-entry program was resident in the 8602 processor and was running under DATASHARE. The DATASHARE utility allowed the order-entry users in our tests to share the DATABUS interpreter and order-entry program code. Each terminal had its own data area and memory was managed by the DATASHARE task. The CPU-Intensive background program was run in the 8601 processor. As the benchmark timings show, this was truly a "background" program in that its execution did not affect the execution of the order-entry program (or vice versa). Had the background program required some disk I/O, it would have impacted the order-entry timings as the 8602 processor was "in charge" of the 20-megabyte disk system.

OVERVIEW OF PROGRAMS AND RESULTS

The benchmark program set consists of:

Speed Tests

- A CPU-Intensive job
- An I/O-Intensive job

"Real Life" Problems

- An Order-Entry program run with varying number of terminals
- An Order-Entry program run with varying number of terminals and background execution of the CPU-Intensive speed test

Speed Tests: CPU-Intensive and I/O-Intensive Jobs

Both the CPU-Intensive and the I/O-Intensive benchmarks were designed to test the speed of specific computing tasks that used repeated, short, individual operations. These tests are identical to those in the Series 1 and Series 2 reports, and provide comparability with those single-user systems.

CPU-Intensive Job

This short program executes a variety of calculations including addition, multiplication, division, square root, and exponentiation. The program runs through an iterative process and, to compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 iterations. The average run-time on this test for the systems in our Series 2 (single-user machines in the $15,000 to $25,000 price range) was 3 minutes, 37.9 seconds, with a low of 14.2 seconds and a high of 7 minutes, 33.0 seconds.

A-8	Results:	N = 3000	57.4 seconds

I/O-Intensive Job

This program stores numbers from 1 to 3000 on the disk, and retrieves the first 50 of them in a factorial fashion (for example, a total of 1,276 reads following 3,000 writes). To compare with the Series 1 and Series 2 benchmarks, we report the average time to complete 3,000 writes and 1,276 reads. The average run-time on this test for the systems in our Series 2 reports was 3 minutes, 22.5 seconds, with a low of 40.8 seconds and a high of 6 minutes, 59.9 seconds.

B-4	Results:	N = 3000	30.3 seconds

"Real Life" Problems

This program is based upon an order-entry system designed for the Association of Computer Users. There are three types of processes: new members, renewals of membership, and payments. Upon joining the Association, member information is input by the operator and stored in a member file, and a packing slip is prepared indicating the items to be shipped. For renewals, the old member record is retrieved and updated as appropriate, and a packing slip is prepared. In both cases, if the individual has not included payment, an invoice document is prepared and the billing information stored in an accounts receivable file. When a payment is made, the receivables record is retrieved and updated with the payment.

The time between an operator pressing a carriage return to end a response and receipt of the next computer prompt is called terminal response time. It is in this interval that the computer is processing information and manipulating files, and we can equate response time to system processing time. We are reporting here "transaction response time," the total accumulated processing time divided by the total number of transactions. Note that each transaction consists of approximately twelve separate input lines.

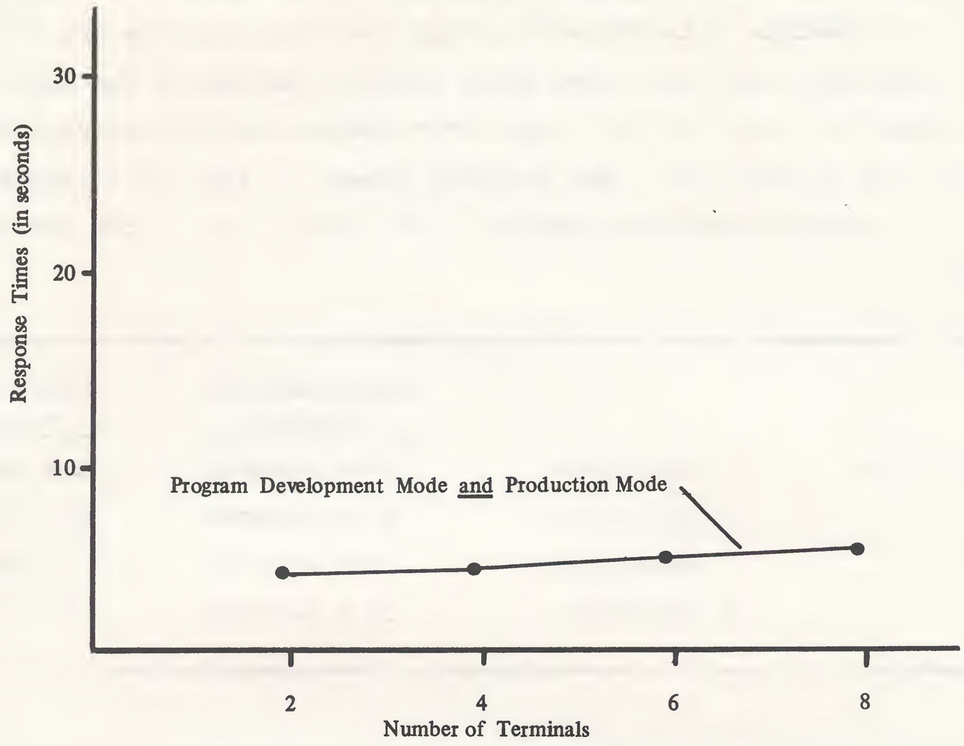
Order-Entry Run in Production Mode

The order-entry program is run with 2, 4, 6, and 8 terminals and no other programs running on the system. This would be a typical production mode application.

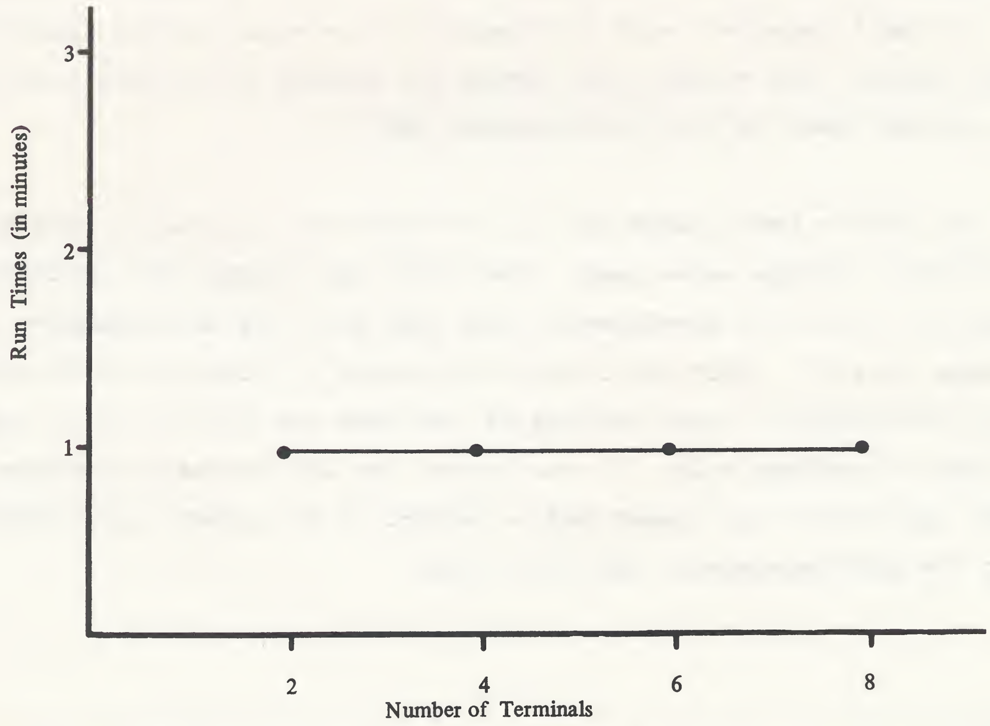
D-1	Results:	2 terminals	4.2 seconds
D-2		4 terminals	4.4 seconds
D-3		6 terminals	5.1 seconds
D-4		8 terminals	5.2 seconds

BENCHMARK TIMINGS: DATAPOINT 8600

Order Entry Program
Response Times Versus Number of Application Terminals



CPU-Intensive Program
Run Times Versus Number of Application Terminals



Order-Entry Run with Background Program Development

In a "typical" working environment, a programmer may be developing or testing a new program while the other users of the system are performing their normal activities. To simulate this situation, this test executes the CPU-Intensive program continuously, with the order-entry program running at the same time. Again, the measured times for the order-entry program are the average processing times per transaction. The measured times for the CPU-Intensive program are the average times to complete 3,000 iterations of the computational loop.

			CPU-Intensive Program	Order-Entry Program
E-1	Results:	2 terminals	57.4 seconds	4.2 seconds
E-2		4 terminals	57.4 seconds	4.4 seconds
E-3		6 terminals	57.4 seconds	5.1 seconds
E-4		8 terminals	57.4 seconds	5.2 seconds

Analysis of "Real Life" Problem Results

The graphs on the previous page illustrate the run times for the "real life" problem. The first shows the time for the order-entry program for 2, 4, 6 and 8 terminals without the background program running (production mode) and for 2, 4, 6, and 8 terminals with the background program running (program development mode). The second graph shows the effects of running additional terminals on the times of the CPU-Intensive job.

The Datapoint 8600's performance in our benchmark test placed it in the middle of the benchmark timings we've seen. Note that the timings for production mode are the same as those for development mode (and that the CPU-Intensive timings do not change at all). This portrays an advantage of Datapoint's distributed processing architecture--tasks running at one node (or processor) do not affect those running in another node. In our tests, the CPU-Intensive program running in the 8601 application processor had no effect on the order-entry program running in the 8602 processor, and vice versa.

SYSTEM AS TESTED: DATAPOINT 8600

Costs

Datapoint Model 8630	$33,500
• Integral terminal/keyboard	
• 9301 Disk Drive	
. 20 Megabyte hard disk	
. 20 Megabyte cartridge tape drive	
• 128 Kilobytes of main memory	
Additional 128 Kilobytes of main memory	$ 2,600
Two Multiport Communications Adapters (four ports each)	$ 2,000
Datapoint Model 8601 Applications processor	$ 7,500
• Integral terminal/keyboard	
• 128 Kilobytes of main memory	
Serial Matrix Printer (160 cps)	$ 2,575
Datapoint system software	--
Total System	$48,175

Our Observations

Each processor has an integral terminal/keyboard so that our test configuration as it appears (with no additional terminals) can support two users. Up to eight more terminals can be attached to the 8630, so this configuration can support up to ten simultaneous users. Datapoint 8220 workstations are priced in below for the 4, 6, and 8 terminal configuration (at $1,895 each). The one-terminal configuration given below is the "As Tested" configuration less the two Multiport Communications Adapter boards and the 8601 processor.

Configuration	Total Price
System with one terminal	$38,675
System with two terminals	$48,175
System with four terminals	$51,965
System with six terminals	$55,755
System with eight terminals	$59,545

Prices include all Datapoint software.

Summary of Equipment and Features

- The 8602 processor is an integrated unit consisting of a 16-bit processor with 128 to 256 kilobytes of main memory, an internal Resource Interface Module (RIM) for ARC network operation, extra card slots for optional I/O interface cards, and a terminal with detached keyboard. These are all contained within the terminal enclosure (in fact, the 8602 processor looks just like the 8220 terminal). The 8602 costs $10,950.
- The 8601 processor is similar to the 8602 but cannot be enhanced with additional cards for disk and other I/O interfacing. It does have a RS-232C port for local printer support and can, of course, be attached to the ARC network and thereby share the resources (disks, printers, etc.) of other processors on the net. The 8601 is priced at $7,500 and can be upgraded to a 8602 for $4,500.

Our Observations

The 8600 family of processors was announced in September of 1981 and features a CPU patterned after the Datapoint 6600. The 8600 has the RIM for ARC operation as an integral LSI chip (as opposed to the external black box used previously). The 8600 also employs Direct Memory Access (DMA) in its disk data transfers. The DMA technique permits very high speed transfers without having to pass through the processor.

The users we spoke to in our survey were generally pleased with their 8600 systems citing high reliability as a prominent feature, though many felt that processing speed was no better than average. Universally applauded was the local networking/distributed processing capability of the 8600 via the ARC net.

User Comments

- *We have very few, if any, people who we would consider to be computer operators. One of the benefits of the Datapoint is that we do not have to have manpower just to babysit the computer. It has allowed us to have a 30 percent reduction in manpower.*
- *The 8600's speed is average--concurrent I/O degrades response time, but it's not a problem.*
- *Our network is spread over four floors and works just beautifully. The Datapoint is very much a system you can build on.*
- *We can process more data by just adding another box (processor) without a big conversion job.*
- *The best feature of the Datapoint is the ARC idea, the worst is that it is fairly slow equipment.*

STORAGE DEVICES

Summary of Equipment and Features

- The 8630 system (which we tested) consists of the 8602 processor and the 9301 storage unit. The 9301 is a 20-megabyte hard disk drive, a 20-megabyte cartridge tape drive, an intelligent controller, and a power supply housed in a desk-top size cabinet. The 20-megabyte tape drive can back up the complete disk drive in less than 15 minutes onto a cartridge that will fit in a coat pocket.

- The 8620 system consists of the 8602 processor, the 9310 cartridge disk drive (10 megabytes), and the 1411 diskette drive (1 megabyte). The 8620 is priced at $28,500.

- The 9301 can support up to four 20-megabyte extension drives for a maximum capacity of 100 megabytes. Expansion drives may be added in 20- or 40-megabyte increments (40 megabytes for $13,500, first 20 megabytes for $8,000, second 20 megabytes for $6,000).

Our Observations

We found using the Datapoint cartridge tape backup to be a quick and easy process employing a small, easy to transport and store tape cartridge. Datapoint claims that the tape head should not require replacement under normal use.

The 8602 processor is limited to 100 megabytes of on-line disk storage (using the 9301 and extensions). However, this does not limit a Datapoint system to 100 megabytes. Using the ARC net users may access the disk resources of many 8600 processors (each potentially with 100 megabytes), so that the disk storage capability of a Datapoint local network is virtually unlimited. Even greater storage capacity can be attached to the network by using the more powerful 8800 processor which can support up to one gigabyte (1000 megabytes) of storage.

User Comments

- *One hundred megabytes is more than ample for our needs.*

- *A file must reside on one disk pack. We feel we can't fully utilize all our storage space because we can't "cross-pack."*

- *This Datapoint equipment has been very reliable.*

- *At those times when we have all our workstations going and we are running a very disk intensive job, we see a noticeable slowdown.*

Summary of Equipment and Features

- The 8602 processor is contained in a terminal enclosure with detached keyboard. The screen has a diagonal width of 12 inches, a 24-line by 80-column display, and features keyboard controlled brightness, inverse and two-level video, blinking, and underlining. The characters are formed with a 7-by-9 dot matrix and the display is amber in color (found to be ergonomically correct in studies performed in Europe).
- A variety of printers are available for the Datapoint system. The 45 character-per-second letter-quality printer is available for $5,150, a 160 character-per-second matrix printer costs $2,575 and 300 and 600 line-per-minute printers cost $10,800 and $14,500, respectively.
- The 8220 Workstation is a general purpose CRT terminal. Priced at $1,895, the 8220 provides the same features as the terminal for the 8602 processor (and in fact, looks exactly the same).
- Communications options for the 8600 (besides the standard Resource Interface Module for connection to the ARC network) include a Multiport Communications Adapter (MPCA) and a Multifunction Communications Adapter (MFCA). The MPCA supports four asynchronous RS-232C serial ports at a cost of $1,000. The MFCA provides a serial synchronous or asynchronous communications channel and a reverse channel at a cost of $1,500. A maximum of three MPCA's can be supported by the 8602 processor (for 12 total ports) while a maximum of two MFCA's can be supported (there is a tradeoff between MPCA's and MFCA's because there are just three card slots available in the 8602).

Our Observations

Communications for the 8600 are handled by I/O boards such as the MPCA. These boards, which contain their own Z-80 microprocessors, relieve the Datapoint CPU of handling burdensome interactive and disk I/O chores.

Users we spoke to enjoyed, for the most part, Datapoint peripherals. A notable exception was the 45 character-per-second printer which was the focus of numerous complaints.

User Comments

- *The only device I'm not happy with is the 45 cps printer--it's a dog.*
- *I love the keyboard and screen. If I work with the amber screen all day, my eyes are less tired than with other screens.*
- *The 45 cps printers are a total disaster. They don't print with consistent quality and are awkward to use mechanically.*
- *The keyboard and screen are beautiful, can't say enough about them.*

OPERATING SYSTEM AND UTILITIES

Summary of Features

- The operating system in use for our benchmark tests was Datapoint's Resource Management System (RMS). This multi-user/multi-tasking system offers the "usual" operating system functions (memory and file management, etc.) as well as ARC network resource management.
- Datapoint also offers the Disk Operating System (DOS), a capable and widely used system, though less powerful than RMS.
- All Datapoint software are included in the price of the hardware.

Our Observations

The Disk Operating System (DOS) was Datapoint's first operating system. Created in 1972, DOS was designed for the Datapoint 2200 processor. When the ARC network system was released in 1977 the first version was based on DOS. The DOS version of ARC was (and is) a single tasking version where each processor in the network runs one task. If the processor has a disk attached to it, it serves the function of file server to other processors on the network. These other processors may be doing a sort, or handling a number of non-intelligent terminals, or word processing, but only one function per processor.

As ARC developed and the shared resource concept matured, the Resource Management System was developed by Datapoint to overcome some of the limitations of the DOS-based ARC network. RMS allows multi-tasking so a processor is not restricted to just one function, but may perform several subject to memory limitations. With RMS, a processor may manage a disk resource and perform other tasks simultaneously (as in our benchmark tests where the 8602 processor managed the disk and ran the order-entry application on eight terminals).

The RMS-based version of the ARC net provides each user of the system access to all functions of the system, no matter where that function (a physical device and/or software) resides. Whether a user is at a non-intelligent terminal or at a processor, all functions are accessed in the same manner and with the same commands. Since functions and capabilities can and do change rapidly, RMS employs a modular design which allows additional functions to be added to the RMS nucleus software incrementally.

Datapoint divides the software in an RMS system into the following categories: Nucleus, System, Communications, Languages, and Utilities. Every category, except the nucleus software, is RMS user-level software.

The RMS nucleus software is a library of processor dependent routines. This library contains the software necessary for system initialization, system table and system clock maintenance, peripheral operation, task execution, I/O control, etc.

RMS system software are documented as utilities, but provide system-wide capabilities. These three packages include:

- Batch Job Facility to oversee the execution of procedure files.
- File Management System which manages user file I/O including the ability for multiple users to access common files.
- Enqueue/Dequeue facility which provides systemwide control over access to all resources.

RMS communications software allows data communications using a number of protocols. Included in the available protocols are IBM 2780/3780, IBM HASP, and DATAPOLL.

RMS language software includes DATABUS, DATASHARE, and COBOL (see page 19). Also included is CHAIN, a high-level, structured language used primarily to create a procedure file containing the commands and inputs necessary to execute a job stream unattended. CHAIN also has recursion and file processing capabilities.

The RMS utilities perform many data processing, file manipulation, and system control functions and include:

- General Resource Utilities which provide means to create and manage user resource environments. The environment is a symbolic name for a file which defines the user's scope of access to various system resources and files.
- File Maintenance Utilities including file creation, sorting, listing, etc.
- System Management Utilities including those mentioned above as system software.
- Security and Accounting Utilities for system security and control.
- Various Additional Utilities including DOS to RMS conversion, routines, tape transfer routines, software maintenance routines, etc.

The users we interviewed were generally pleased with RMS though several reported bugs in this new operating system.

User Comments

. *There are some bugs in RMS; seems like they have new releases every six weeks.*

. *We use CHAIN as a programming language and it turns out to be one of their better languages.*

. *RMS is so much more powerful than DOS. It gives more resource control. Conversion from to DOS to RMS was easy.*

LANGUAGES AND APPLICATION PACKAGES

Summary of Features

- Datapoint offers the following languages:

  - DATABUS, a high-level, business oriented, interpretive programming language.
  - DATASHARE, a second DATABUS interpreter which allows multiple users to share a single DATABUS interpreter.
  - COBOL, which conforms to the 1974 ANSI standard.
  - FORTRAN and RPGPLUS.

- Datapoint does not offer application programs with the exception of their word processing package (which is included with the Datapoint system software) called IEOS (Integrated Electronic Office Station). IEOS offers word processing with document and library management facilities. Also included is Datapoint's Associative Index Method (AIM) software for text file searching.

Our Observations

The DATABUS language is very similar in structure to a two-operand assembly language when there is a label, an operation code, and operands. It is easy to learn and compiles into pseudo-code extremely fast (on the order of 2,000 lines in less than a minute). This pseudo-code is then executed by the DATABUS or DATASHARE interpreters.

Though we felt that DATABUS is a little too simple (with its lack of structured statements and its assembly-like structure), the users we spoke to enjoyed its simplicity and were basically quite happy with DATABUS.

User Comments

- *DATABUS is super. It's easy to use, compiles fast, and executes fast.*
- *DATABUS badly needs an IF-THEN-ELSE statement.*
- *DATABUS has some pretty good features. We use it for the input side and use COBOL for writing reports.*
- *Our operators like IEOS.*
- *IEOS has been beautiful. We have 35 clerical staff using eight terminals. All but one or two were trained in-house. IEOS is very user-oriented and easy to learn.*
- *In my opinion, Datapoint with ARC and IEOS is light-years ahead of everyone else.*

Summary of Features

- Hardware and software maintenance is offered either by Datapoint itself (through Datapoint offices) or by Datapoint vendors (independent firms that sell Datapoint equipment and their own application software).
- Datapoint publishes a catalog which outlines 14 different customer education courses offered at various locations throughout the country (on-site classes can also be arranged). These classes cost $600 per person and generally run about four days.
- The Datapoint Systems newsletter, "Source Data," is published every two months for Datapoint users. These newsletters contain updated product information, helpful articles, and information of interest to Datapoint users.

Our Observations

If a Datapoint system is purchased from a Datapoint office, the customer may also purchase a maintenance contract from Datapoint or elect to have maintenance performed on a time and materials basis. Software support is supplied at virtually no cost by the Datapoint office. If a customer purchases a system from a Datapoint vendor (or OEM), hardware maintenance is handled similarly, but software maintenance is now handled by the OEM (who is supported by a Datapoint office).

As has often been the case, the users we interviewed had rather mixed opinions regarding Datapoint's documentation. Conversely, users were nearly unanimous in their praise of the service received from Datapoint.

User Comments

- *Datapoint documentation is not the best. It's not precise enough. I have to go through three or four documents to get answers.*
- *Datapoint documentation is average.*
- *Their documentation is very good.*
- *. . . Another good feature of their product is their service. We have 100 offices spread over five states and they service all to our satisfaction.*
- *One of the reasons we bought Datapoint equipment is because they convinced us they had the service to back it up. So far, that has proved to be true. They respond very quickly.*

SUMMARY OF USER COMMENTS

Using names supplied by Datapoint, we interviewed eleven users of the Datapoint 8600. Most of these users were employing the ARC local network. These firms included several banks, wholesale distributors, an engineering and construction firm, and large departments within other organizations. They had owned Datapoint equipment from three months to one-and-a-half years and were using the machines 40 or more hours a week. Most of these users had used Datapoint equipment for some years and had upgraded to the ARC net. Others had not used a computer or had time-shared with a mainframe in their company. Reasons given for choosing Datapoint were usually its modularity, versatility, and previous experience with Datapoint equipment and the company. Users' applications varied but about three-fourths of them were using the Datapoint for word processing. In addition to word processing, other uses included color graphics, electronic mail, scheduling, and accounting functions.

Specific hardware configurations were unique at each installation. Most had 128 kilobytes of main memory per processor which included 3300's, 6600's, 8600's and 1800's. Total processors ranged from 6 to 30 in each organization. The majority of users were using the 45 cps letter quality printers, though a few owned the 160 cps matrix printers. Users had a variety of CRT's including the models with amber screens and detached keyboards. The operating systems in use were about half DOS and half RMS. DOS was well liked and most users said it was simple to use. Those with RMS were more enthusiastic about it and said it was flexible, powerful, and offered a lot of potential.

The 45 cps printer was viewed as "a dog" and the "weak link" of the system. Users said it frequently broke down, was noisy, had poor and inconsistent print quality and that it was ackward to operate mechanically. Other Datapoint printers, including the 160 cps printer, worked better for the users. Users gave mixed reactions to the keyboard and screen of the 8600's. The keyboard's best features were said to be the touch, that it could be reconfigured, and that it was detached. Conversely, the major complaint was that the touch was "stiff" and "too heavy." Some users said the amber screen was easy on their eyes, though they felt that the character size actually made the screen more readable than the amber color.

Central memory for each processor was usually 128 kilobytes which all the users said was "ample." Total disk storage ranged from 10 megabytes to 540 megabytes. Perceptions of system speed varied--some users said the system was slow or that "no processor was fast enough"--yet no one felt that speed was a problem. On the other hand, there were users who said its speed was "hard to beat" or "very good." Word processing was said to slow it down as did heavy I/O jobs.

The most frequently used languages were DATABUS and COBOL. Negative comments about DATABUS were that its file handling was strange, and it "badly needed an IF-THEN-ELSE statement;" otherwise users liked it. They said it was easy to learn and teach to others, it was easy to program, and compile/execution times were fast. Several users also commented favorably on its COBOL-like features. Users liked Datapoint's COBOL, but said it was slower than DATABUS and took up more memory.

The users generally liked the Integrated Electronic Office Station but mentioned some drawbacks which included slow speed, infrequent updates, and awkward editing. One user said that IEOS (Integrated Electronic Office Station) was beautiful and very user-oriented. In general, Datapoint's software was well liked. While some of it may not have been considered state-of-the-art and even contained bugs (especially RMS), it worked and many users commented that Datapoint put out frequent updates.

Users had mixed opinions about Datapoint's documentation, though the consensus seemed to be that it was average. Training was felt to be "pretty good" by most of those interviewed, and all agreed that hardware service was good. Some felt that Datapoint's support of their software was lacking.

The aspects of the Datapoint that the users were most pleased with were its multi-tasking and networking capabilities. Several users said Datapoint was the only manufacturer with a proven, reliable networking system and that they were leaders of the industry in that area. Other features of the Datapoint that were frequently applauded were its modularity and flexibility. Users noted that a big conversion wasn't necessary each time an owner wanted to add more power. Overall, these users were exceedingly pleased with their Datapoint 8600's and they intended to stay with Datapoint equipment.

CONCLUSIONS

When Datapoint was started in 1968, the original focus was on the computer terminal market. In 1972, they released their first minicomputer system, the 2200. Since that time, Datapoint has developed several other systems and in 1977, released the first version of their Attached Resource Computer (ARC) local network. Now, as an acknowledged leader in local computer networks, Datapoint offers what they describe as a "third generation" network (with the fourth generation announced and on the way).

The Datapoint ARC network allows full distributed processing/resource sharing capabilities. Users throughout the system can access software and hardware functions regardless of the geographical dispersion of the equipment or programs. The hardware connections required (basically a coaxial cable) are perhaps the simplest and most troublefree in the industry. From the software perspective, users need know little about networking as the RMS operating system (Resource Management System) takes care of the network communication chores.

All Datapoint software is fully bundled into the system price and includes a full line of system utilities, file management utilities, programming languages, and Datapoint's IEOS (Integrated Electronic Office Station). IEOS is Datapoint's word/document processing system and was generally well-received by the users we spoke to in our survey.

Though we felt the DATABUS programming language had some weaknesses, it proved to be a capable performer in our benchmark tests. The 8600's order-entry program timings were about in the middle of those we've seen and due to the dual-processor configuration employed in our tests, exhibited no response-time degradation when the CPU-Intensive program was run in the background.

The users we interviewed were generally pleased with their Datapoint system and especially pleased with the proven and reliable ARC networking system. Citing modularity, versatility, and good system support, these users intend to stay with Datapoint equipment. From our benchmark tests, we can see why.

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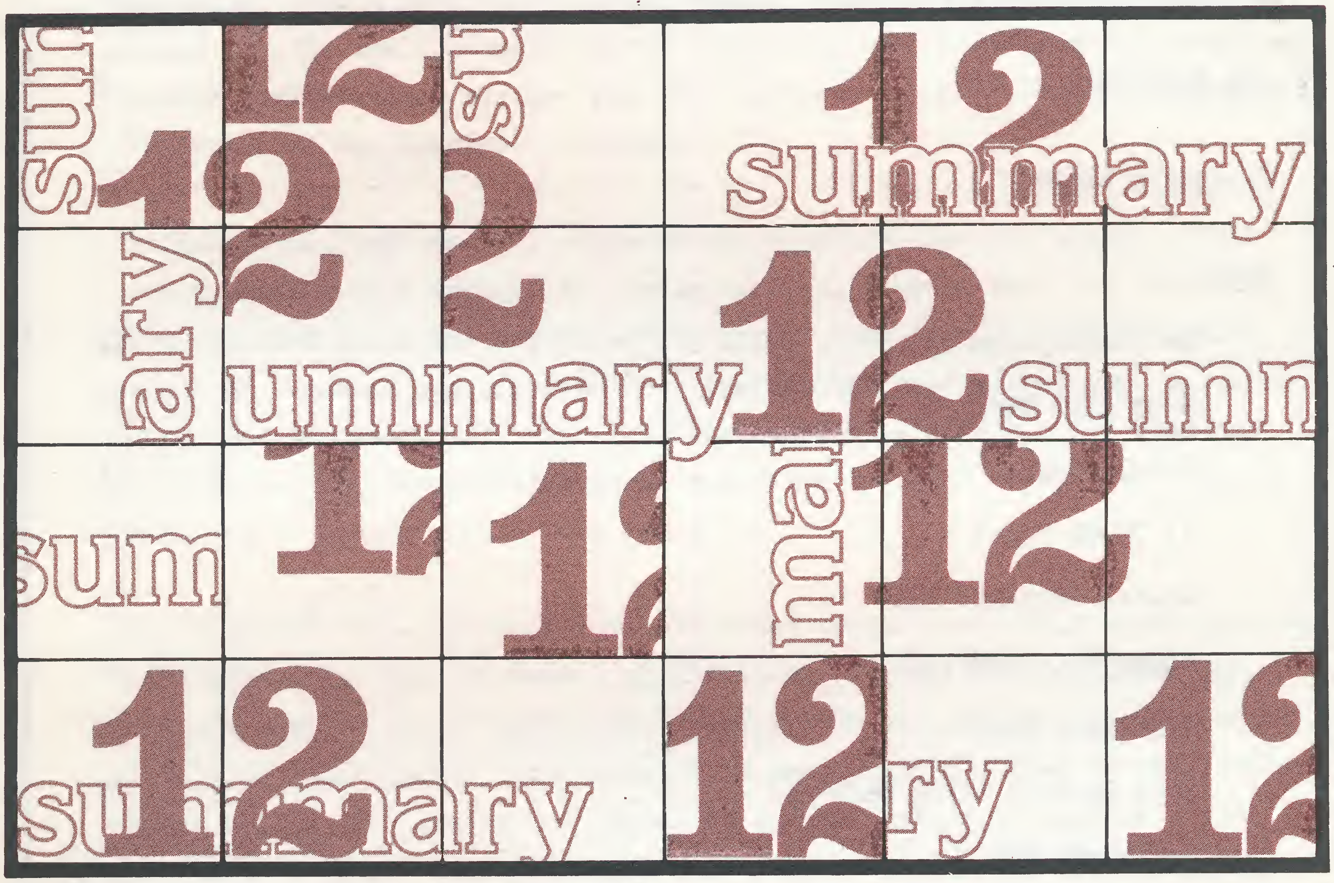

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12 ISSUE SUMMARY REPORT

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PREFACE

This is the concluding issue in this series of reports covering multi-user systems in the $25,000 to $50,000 price range. In this 12-Issue Summary we provide side-by-side results of our benchmark timings of twelve computer systems, along with capsule summaries of observations and user comments made during our evaluation of each system. This summary, along with the more detailed coverage in the individual reports, provides a valuable resource for anyone contemplating the purchase of a computer system.

The report starts with an Executive Summary which briefly summarizes each system. Next, the Benchmark Process describes the procedures and programs used to evaluate each system, followed by the Benchmark Summary, a detailed comparison of the Benchmark timings.

Profile pages cover the key features and drawbacks of each system, along with updates noting changes in configurations, prices, and features which have occurred since the report was written. Finally, we conclude with a number of comments and observations covering the analysis of your business needs, and procedures for system evaluation and selection. Our comments are based on our own experiences in selecting systems, as well as those of users interviewed over the past few years.

Over the past three years we have evaluated twenty-four single-user systems and twelve multi-user systems. Capabilities, features, prices, and performance have varied considerably. Each system has had its strong points as well as limitations. Obviously it is impossible to cover in this summary report all of the information contained in the individual reports. The purpose here is to highlight major differences and provide quick comparisons. The individual reports contain details which illustrate subtle differences among the systems, as well as our comments about evaluating capabilities, making trade-offs of features, and suggestions for choosing a system.

EXECUTIVE SUMMARY

The following paragraphs as well as the profiles given on pages 10 through 21 are brief sketches of the twelve systems highlighted in this issue. The reader should refer to the complete benchmark reports for a more in-depth analysis of each system.

- DEC DATASYSTEM 355. The DS 355's timings were about in the middle of other systems tested. Users cited the DEC as being reliable and easy to use. Many application programs are available for the DS 355 and at the time of our tests, DEC was starting to develop more end-user software. The field and time proven reliability of the PDP 11/34 processor and compatibility of software across DEC systems are added features of the DS 355, that help make it a good business system.

- WANG 2200 MVP. The Wang came in with the fastest group of systems tested. Timings with eight terminals were about one second slower than timings for two terminals. There is a staggering array of software available for the 2200 MVP produced by both Wang and their "approved" vendors. Overall, the Wang is a good business system, faster and less expensive than some of the other twelve computers evaluated in this series.

- IBM SERIES/1. The Series/1 came in first on the CPU-intensive problem and was relatively fast on the I/O-intensive problem. Due to technical problems, however, a complete set of benchmark timings could not be made. The Series/1 is a versatile, powerful and complex "mini-mainframe." One of the more expensive systems (price as tested did not include software), it is a capable performer and should be purchased either as a turnkey system or by a large organization which has competent data processing personnel.

- TI DS990 MODEL 4. The Model 4 was one of the slowest systems on the CPU-intensive program yet it placed in the middle for the I/O-intensive and order-entry processing problems. The users we surveyed were pleased with all aspects of the system; they especially liked the reliability of the TI equipment and the user/system interface engineered into the operating system. The DS990 is a versatile system for both business and scientific and engineering applications.

- HEWLETT-PACKARD 250. The HP 250 placed third on the order-entry program and first on the I/O-intensive program. It was not as fast on the CPU-intensive problems, however. Users expressed great satisfaction with their 250's, and credited it to the user-friendly features designed into the system. The HP 250 is easy to program and is a good system for both experienced and inexperienced users alike.

- ALPHA MICRO AM-100T. The Alpha Micro's timings placed it in the upper third for speed. Alpha Micro system software gives the AM the appearance and performance capability of a much larger system. Less expensive non-intelligent terminals may be attached to the system; this ability and other hardware features make it a system that is easily expanded at an affordable price. The AM is a powerful yet relatively inexpensive system.

- <u>MICRODATA 4000</u>. The 4000 placed in the slowest group on the CPU-intensive problems but it was one of the fastest systems on the order-entry processing problem. The Microdata is a large capacity, virtual memory machine with a very sophisticated operating system. The ENGLISH programming language was said by users to be easy to learn and use. Although the Microdata is one of the more expensive systems we tested, we feel its capabilities outweigh its cost and would give a user power, flexibility and ease of use.

- <u>DATA GENERAL CS/50 MODEL C5</u>. The CS/50 was among the slowest of the systems we tested. Its timings on the I/O-intensive problem put it in the middle of other systems for that test. Data General orients their software to the program developer and OEM, who in turn produce software and turnkey packages for the end-user. The operating system and application software are compatible across the CS line making hardware upgrades easier. These and other factors make the Data General a system worth considering.

- <u>BURROUGHS B91</u>. Since the B91 could not be interfaced with our Remote Terminal Emulator (RTE), we could not conduct timing tests that are directly comparable to other systems tested. Burroughs has developed an extensive line of application software and all software may be moved across a family of Burroughs computers. In the area of hardware, Burroughs has developed a high capacity floppy disk and impressive communications capabilities. The B91 is a good system with state-of-the-art equipment.

- <u>ALTOS ACS8000-10</u>. The ACS8000-10 was limited to four terminals and as such, we could not get a complete set of benchmark timings. The timings we did run show that the Altos was one of the slower systems tested. The ACS8000-10 has hardware restrictions that make comparisons with other systems tested in this series difficult. Nevertheless, it is a functional multi-user system operating under the OASIS operating system. The Altos is a very cost-effective system for anyone needing the capacity offered.

- <u>ULTIMATE A1</u>. The A1's timings were the fastest on the order-entry benchmark yet its CPU-intensive timing was one of the slowest. Ultimate's software employs virtual memory techniques and is oriented toward data base management. Users were pleased with the system software but were unhappy with system reliability and support. System utilities and the language RECALL are user-oriented and help to make the A1 an excellent system.

- <u>DATAPOINT 8600</u>. The 8600's timings were in the middle of other systems but because the CPU-intensive background program was run in a separate processor from the order-entry program, the production mode and development mode timings were the same. This illustrates one of the 8600's strongest points, that is, the ease with which processors may be added wherever power is needed. Power, versatility, modularity, and good system support make the Datapoint an attractive, effective computing system.

THE BENCHMARK PROCESS

While there are a number of factors involved in evaluating a computer system--languages, operating system, applications software, maintenance, and supplier support--everyone asks for some single measure of system performance on which to base comparisons. When the performance question is asked, the answer is often a technical one--MIPS (millions of instructions per second), disk access speeds and transfer rates, channel speeds and capacity, etc. The problem with these measures is that they have little basis in the reality of the application for which the system will be used.

In his excellent article on the measurement of computer throughput ["Tracking the Elusive KOPS," by Edward J. Lias, in Datamation, November, 1980, pp. 99-105], Lias discusses MIPS and KOPS (thousands of operations per second) and notes that they are measures of processor speed but not computer throughput. Throughput depends not only on processor speed, but on the efficiency of the compiler, the operating system, the power of the instruction set, the job mix, and peripheral performance. He concludes that there is one factual and reliable measurement which can help in choosing from among the systems available--benchmarking, which focuses on actual throughput and output.

Benchmarks are based on computer programs designed to run, without change, on a number of different computing systems. There are two principal criteria used in the design of benchmark programs: the job/instruction mix to be tested, and the ability to compare across systems.

> The job mix is the set of programs which represent the general activities in which the user is interested. For example, ACU's benchmark programs test raw computing power through the CPU-intensive program, disk access through the I/O-intensive program, and multi-terminal response through the Order-Entry program.
>
> Within each program, the particular mix of instructions must be determined. Since the order-entry application had a specific sequence of actions to perform, the set of instructions was well defined. The I/O and CPU programs required an explicit definition of the statements which would measure those raw computing capabilities of interest.
>
> To maintain the ability to compare across systems, the choice of tests must be restricted to the set of capabilities found on the majority of computers to be tested. Those things which a system can do in addition to the minimum procedures are then considered "extras" in the evaluation process.

The single user CPU- and I/O-intensive programs used in this series of reports are identical with those used in the Series 1 and Series 2 reports, and are included to provide comparability with those computers costing under $25,000 in a single user configuration.

- CPU-Intensive program. This particular program is predominantly a test of two specific functions (exponentiation and root) which would be used in numeric computations of a more scientific nature. While we can't point to a specific application for which this is a representative program, it does measure the care with which each manufacturer has implemented scientific functions.

- I/O-Intensive program. This program reads and writes, sequentially, a set of numbers on the disk. Sequential access was chosen since this was the only method available on many of the small systems. Additionally, the purpose of the test is to measure disk access speed--a combination of head movement, storage capacity, and data transfer rates--and sequential access provides the purest measure of this.

The remaining program was designed specifically for testing multi-user capabilities in a real-world application.

- Order-Entry program. This program, using three indexed-sequential files, processes orders, and outputs shipping documents and invoices. Run with two, four, six, and eight terminals inputing orders, and repeated with the CPU intensive program running in the background, it measures degradation in response as terminals are added to the system.

  In order to measure this response time, we have developed a computer program which runs on a North Star Horizon and emulates up to eight remote terminals communicating with the test computer (our Remote Terminal Emulator, or RTE). The RTE feeds a script to the test computer and measures response times for each prompt.

  There are three characteristics of the RTE which are important in interpreting results.

  1. Communications between the RTE and the test computer run at 30 characters per second. Thus, a computer with zero processing time would still be measured at 0.9 seconds response time per transaction (11.8 input lines each) due to communication channel delays.

  2. While we report response times to the nearest tenth of a second, they are measured to the nearest hundredth. Measurement error could be as large as .12 seconds per transaction. However, because we are effectively sampling from 22 to 88 transactions, we would expect the error to be much smaller.

  3. There is some variability in the response of the computer under test. We do perform selected re-timings, and gross errors would be obvious from the graphs included in each report.

BENCHMARK SUMMARY

	DEC DATA-SYSTEM 355	WANG 2200 MVP	IBM SERIES/1	TI DS990 MODEL 4	HEWLETT-PACKARD 250	ALPHA MICRO AM-100T
	RESULTS Seconds	RESULTS Seconds	RESULTS Seconds	RESULTS Seconds	RESULTS Seconds	RESULTS Seconds
CPU-INTENSIVE						
A-4		15.2			24.7	31.4
A-8	38.8		4.9	110.3		
I/O-INTENSIVE						
B-4	46.7	11.2	23.1	47.0	10.0	42.9
ORDER-ENTRY						
D-1	5.0	2.8	7.9	3.8	2.1	3.1
D-2	7.3	3.0	8.0	3.9	2.2	3.2
D-3	11.9	3.3	---[a]	4.0	---[c]	3.8
D-4	16.5	3.5	---[a]	4.3	---[c]	4.0
CPU-INTENSIVE (with Order-Entry running)						
E-1	44.7	15.5	---[b]	116.1	48.2	33.4
E-2	61.7	15.8	---[b]	122.9	47.6	37.0
E-3	71.8	16.0	---[b]	128.8	---[c]	42.6
E-4	84.1	16.4	---[b]	135.2	---[c]	45.2
ORDER-ENTRY (with CPU-Intensive running)						
E-1	7.5	3.5	---[b]	3.9	2.2	3.8
E-2	9.3	3.8	---[b]	4.0	2.3	4.0
E-3	13.5	4.1	---[b]	4.1	---[c]	5.1
E-4	16.1	4.6	---[b]	4.3	---[c]	5.7

[a] D3-D4 could not be run on the Series/1 due to memory limitations.

[b] E1-E4 could not be consistently run on the Series/1 due to an apparent loss of characters in order-entry processing.

[c] Five was the maximum number of terminals that could be run on the HP 250 for the benchmark tests.

BENCHMARK SUMMARY

MICRO-DATA 4000 RESULTS Seconds	DATA-GENERAL CS/50 C5 RESULTS Seconds	BURROUGHS B91 RESULTS Seconds	ALTOS ACS8000-10 RESULTS Seconds	ULTIMATE A1 RESULTS Seconds	DATAPOINT 8600 RESULTS Seconds	
						CPU-INTENSIVE
			305.5	123.7		A-4
197.5	56.3	8.0			57.4	A-8
						I/O-INTENSIVE
40.3	34.5	14.7	82.5	116.7	30.3	B-4
						ORDER-ENTRY
1.6	5.0	---[d]	5.4	1.4	4.2	D-1
1.7	5.4	---[d]	6.9	1.4	4.4	D-2
1.9	6.2	---[d]	---[e]	1.5	5.1	D-3
2.5	7.3	---[d]	---[e]	1.5	5.2	D-4
						CPU-INTENSIVE (with Order-Entry running)
204.4	65.8	---[d]	473.1	126.4	57.4	E-1
212.1	76.4	---[d]	---[e]	130.3	57.4	E-2
223.5	90.3	---[d]	---[e]	135.3	57.4	E-3
239.7	112.4	---[d]	---[e]	---[f]	57.4	E-4
						ORDER-ENTRY (with CPU-Intensive running)
1.8	6.6	---[d]	6.8	1.6	4.2	E-1
2.0	7.4	---[d]	---[e]	1.7	4.4	E-2
2.4	8.8	---[d]	---[e]	1.9	5.1	E-3
3.4	9.8	---[d]	---[e]	---[f]	5.2	E-4

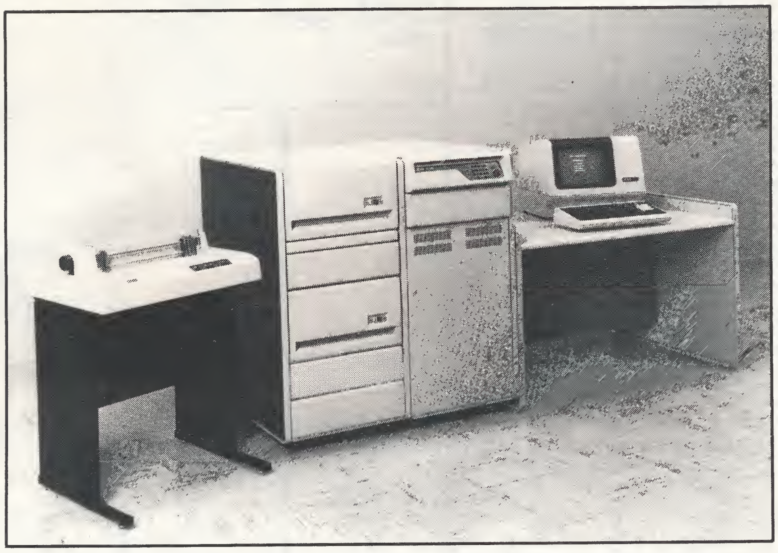
[d] Burroughs timings for these programs are not directly comparable to other systems in this series since the benchmarks were run using Burroughs own RTE.

[e] The maximum number of terminals that could be run at one time on the ACS8000-10 was four.

[f] With a printer in use, the maximum number of terminals that could be run on the Al was seven.

PROFILE: DEC DATASYSTEM 355

Price as Tested = $43,550



BEST FEATURES.....The DS 355's best feature is its place in a family of reliable and proven DEC equipment. The PDP-11/34A is a 16-bit, byte addressable processor. Programs written for this processor are transportable to other DEC systems. Eight terminals may be attached as well as up to eight hard disks of either 10.4 megabytes, 28 megabytes, 67 megabytes or 176 megabytes. With the CTS300 operating system dynamic partitioning and sub-routine overlays are possible. Other options include magnetic tapes and cache memory. At the time of our test, Digital was becoming committed to writing and supplying more end-user application software.

DRAWBACKS.........System generation can be complex, though this will often be done by the vendor. The operating system commands are input line-by-line rather than being menu-driven.

UPDATE: *The DS 355 has been replaced by a similarly configured system called the DS D365D-CA. Standard features include 256K MOS main memory, 20 megabytes hard disk and software including DECFORM, a program generator. Price for this configuration is approximately $3,000 more than the system we tested.*

PROFILE: WANG 2200 MVP

Price as Tested = $34,500

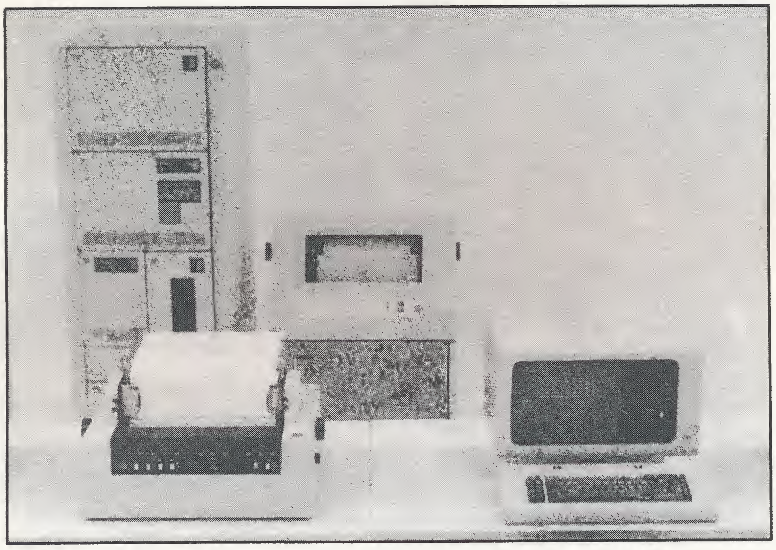
BEST FEATURES.....The 2200 MVP is a well designed fast system with few limitations. BASIC-2 is a highly enhanced version of the BASIC language. A combination of BASIC-2 commands and utilities provide the user/system interface and as such, there is no job control language. A great deal of both scientific/engineering and business application software has been written for the 2200, as well as Wang's own general business packages and program development tools. The system incorporates memory partitioning and a global data area. In a maximum storage configuration a total of 484 megabytes of on-line storage is possible.

DRAWBACKS.........Though users mentioned a lack of support by Wang, the situation has greatly improved since we did the interviews. File management is up to the user since the system does not pack records into disk sectors automatically.

UPDATE: *Versions are available with 2 to 32 megabytes Winchester hard disk, with a 1.2 megabyte floppy disk drive. Up to 512 kilobytes of central memory is also available. BASIC-3 has been introduced which offers automatic file handling capabilities. Added system utilities include spooling, file indexing and screen and menu generation. Other software options include COBOL and word processing programs.*

PROFILE: IBM SERIES/1

Price as Tested = $52,375



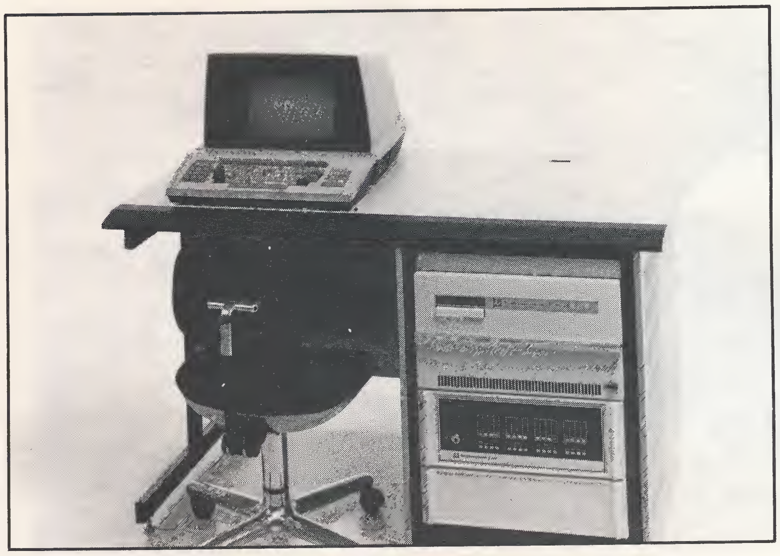
BEST FEATURES.....The Series/1 is what we called a "mini-mainframe" which is a powerful and versatile computing system. Its hardware and software modularity allow a user to tailor the system to fit his needs. With the increase in flexibility, though, comes an increase in system complexity, requiring more resource management than some other systems might need. Languages available with the EDX operating system are PL/1, FORTRAN, and COBOL. The benchmark tests were run using IBM's COBOL which is a standard version of the language without many enhancements.

DRAWBACKS.........IBM sells this equipment "unbundled," thus the price given does not include software. A "typical" multifunction installation would require about $10,000 more in software purchases. In most cases, however, this software can be leased. Users were not as enthusiastic about the software as they were the hardware. They felt the EDX operating system and languages were not as sophisticated as they could be.

UPDATE: *IBM has announced a new processor, the 4954, with a level of price and function between the 4952 and the 4955. It provides almost twice the power of the 4952. Prices of the components we tested have changed, some have increased (the 4964 Diskette unit and the 4963 64 megabyte primary disk unit) while the 4955 Model E processor has gone down about $2,000. The net effect is that the total system price has stayed approximately the same.*

PROFILE: TI DS990 MODEL 4

Price as Tested = $36,635



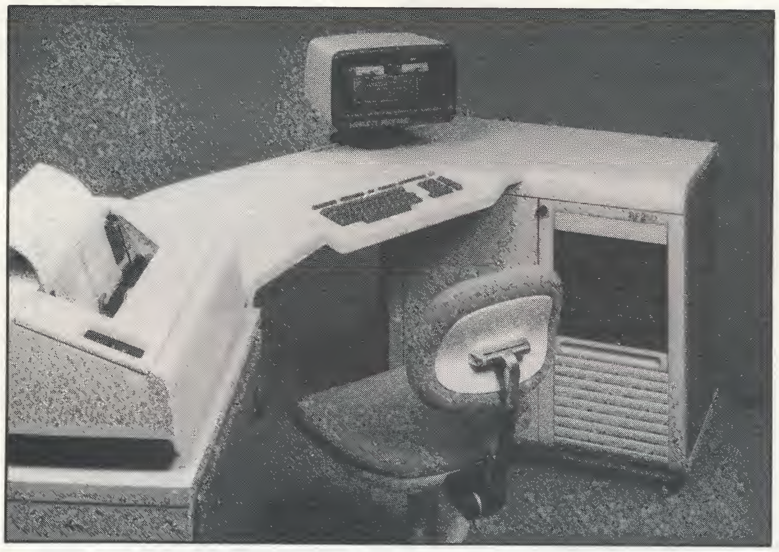
BEST FEATURES.....One of the nicest features of the DS990 Model 4 is the DX10 operating system. It provides a mapping facility which dynamically allocates memory which can be expanded up to 2048 kilobytes. Additionally, it provides roll-in and roll-out priority setting capabilities. With an optional menu-driven approach to using the system, a novice user can easily use and learn the system. Users we surveyed were very happy with this and other "user-friendly" aspects of the system. As many as 20 terminals were attached by one user and a card reader is also an option for DS990's.

DRAWBACKS.........Users expressed some dissatisfaction with the organization of TI's manuals. We saw room for improvement in the time consuming process of setting up procedure files for linking programs. TI does not supply application software but a network of TI dealers insures a variety of software for the Model 4's.

UPDATE: (There were no changes reported by the manufacturer.)

PROFILE: HEWLETT-PACKARD 250

Price as Tested = $30,350



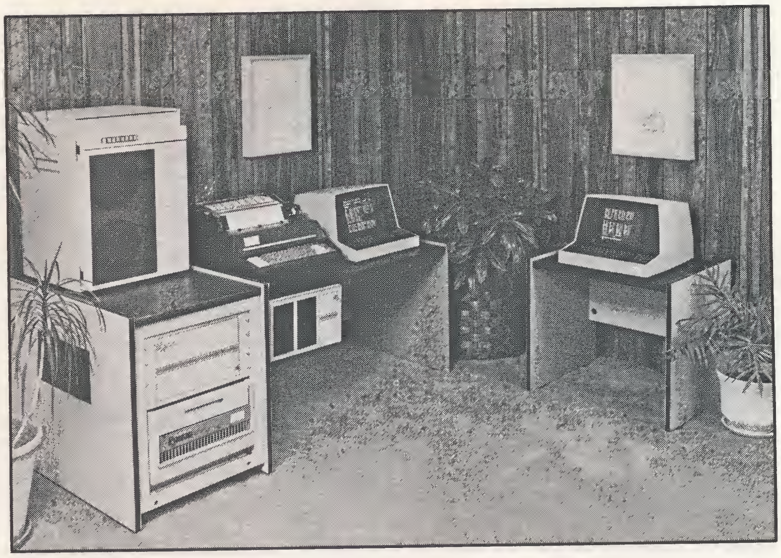
BEST FEATURES.....The HP 250's user-oriented features make it an attractive and well received computer. These features include programmable "soft keys," an adjustable CRT, and the 250 workstation itself. HP's BASIC is enhanced, semi-compiled, easy to program and has full-screen editing. This BASIC, a data base management system, a forms generator and other software are included in the price.

DRAWBACKS.........Although the HP could only support six terminals, its performance on the benchmark tests make it a good competitor with some of the faster systems. User dissatisfaction was usually a result of a poor relationship with their HP dealer or OEM.

UPDATE: *Tape cartridges as well as hard disks are available in 16.5, 27 or 64 megabyte sizes. A user may also delete a 64K board and add 128K for $750. A total of seven terminals can now be run on the HP.*

PROFILE: ALPHA MICRO AM-100T

Price as Tested = $35,680



BEST FEATURES.....The strongest feature of the Alpha Micro is the system software which includes the AMOS operating system with multi-tasking and multi-programming capabilities; AlphaBASIC which is compiled but may be used in an interactive environment; and a full-screen editor. Another feature of AMOS is the ability to create and execute command files. The Alpha Micro may be expanded to 24 terminals and 2400 megabytes of hard disk storage. The system will also run with "dumb" terminals rather than the more expensive "smart" terminals required by some other computers.

DRAWBACKS.........Though there were problems with frequent system crashes, most users felt that Alpha Micro was doing a good job of correcting and improving system software. Memory could be a problem in some applications since only 64K minus sharable memory (16K or more) is available for programs.

UPDATE: *A video tape backup subsystem is now available.*

PROFILE: MICRODATA 4000

Price as Tested = $50,495

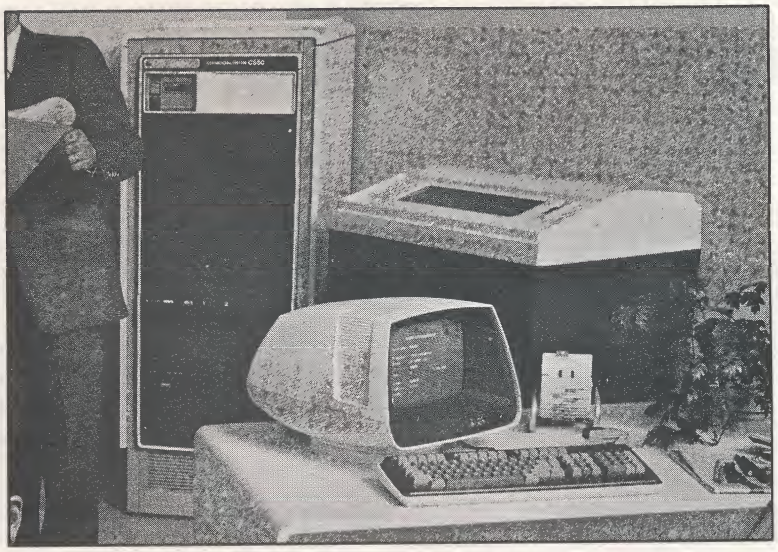
BEST FEATURES.....The Series 4000 is completely oriented toward data base management and this orientation directly affects the design of the languages and the architecture of the CPU. The 4000 has virtual memory where the disk is addressable as if it were main memory. Then sections or frames, called pages, are read off the disk and used when needed. Software includes DATA/BASIC, an enhanced BASIC, ENGLISH, a retrieval/report generator language, and a set of business programs called RESULTS. The Series 4000 can accommodate 32 users and 100 megabytes of hard disk. A Series 6000 can be increased to 256K and 514 megabytes.

DRAWBACKS.........Some users were unhappy with the speed of the system, although they did feel that more memory would alleviate some of the degradation. Microdata documentation was also felt to be inadequate.

UPDATE: *Microdata has discontinued the Model R4510 used in the benchmark tests. A somewhat smaller capacity system is being marketed and costs nearly $5,000 less for a one terminal configuration.*

PROFILE: DATA GENERAL CS/50 MODEL C5

Price as Tested = $44,185



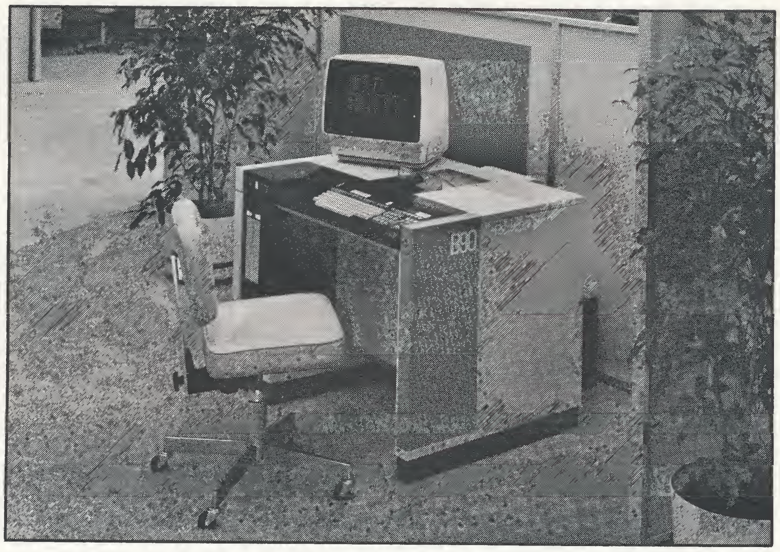
BEST FEATURES.....The CS/50 Model 5 is another computer system which is part of a product line (the Commercial Systems) where the operating system, language and application software are all portable across the manufacturers product line. A maximum of 80 megabytes of hard disk on the C5 or 760 megabytes on the C6 is possible. A printer may be attached to any Data General terminal. A unique distinction of the CS computers are the three operating modes a user operates in: utility mode, application mode, and concurrent mode.

DRAWBACKS.........The CS/50 Model 5 is a "COBOL" machine, which is the only language available on CS systems, making it primarily a business system. Data General does not support end-user application programs, but they do provide some core accounting packages for customization by the .OEM's. Users were a little unhappy with the Data General peripherals, especially the slow speed of the LP2 printers.

UPDATE: *The price of the configuration we tested is about $700 less. However, another configuration similar to the one tested and costing $3,600 less has 25 megabytes of hard disk storage and is supplemented with a 1.2 megabyte floppy disk subsystem.*

PROFILE: BURROUGHS B91

Price as Tested = $28,562



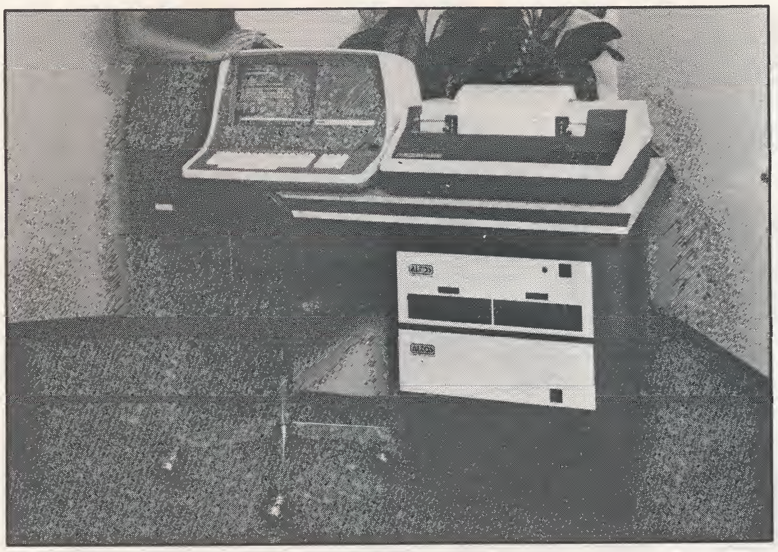
BEST FEATURES.....Burroughs offers an extensive line of end-user software that covers many business applications. The users we surveyed indicated that they were pleased with the packages' performance and with Burroughs support. Burroughs has developed a high capacity floppy disk system which holds 3 megabytes per 8-inch disk. The B91 employs a technique called pipelining which improves processor speed and efficiency. One of the outstanding features of the system is the flexibility provided in data communications where off-the-shelf interfaces with standard or user-developed protocols can be used. The B91 is part of a line of Computer Management Systems (CMS) where application software is portable throughout.

DRAWBACKS.........Negative comments about the B91 from users focused on Burroughs' documentation. We also felt the manuals were lacking but this is certainly not uncommon in the computer industry.

UPDATE: *Burroughs has released a new data communications controller called Data-Comm Power Pack, that has a 38,400 baud rate and a 32-character buffer. Also announced is a new processor providing an upgrade path for B90 series users which will give them two to three times more power and is object code compatible. In the area of software Burroughs now offers Word Management System, a word processing package, and Office One, a collection of office automation programs.*

PROFILE: ALTOS ACS8000-10

Price as Tested = $12,340



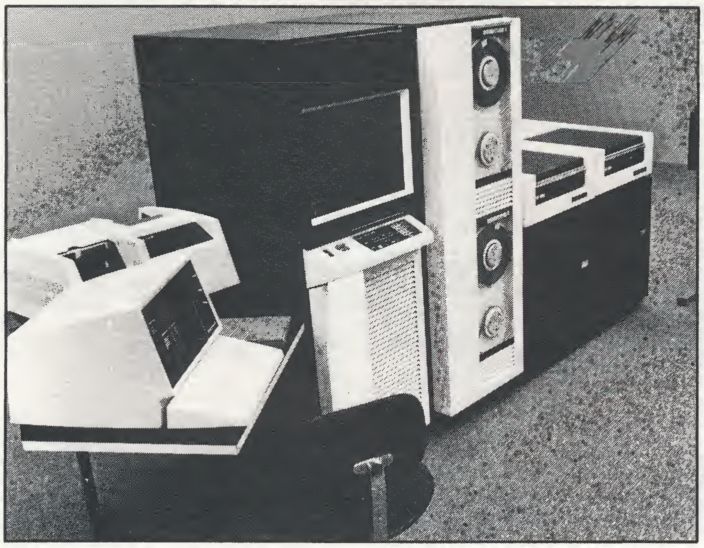
BEST FEATURES.....The OASIS operating system gives the Model 10 much of its power and makes it a capable multi-user system. Although the MP/M operating system is available, OASIS appeared to be better integrated and easier to use at the time of the testing. Though Altos does not market application software, a large number of application programs have been written that can be run on the Altos. Additionally, there are many languages that can be used including BASIC, COBOL, FORTRAN, APL, PL/1 and Pascal.

DRAWBACKS.........The ACS8000-10 is limited in several ways, with disk capacity, the maximum number of simultaneous users (four), and an 8-bit processor. However, for its price, these shortcomings may be insignificant for some businesses.

UPDATE: (There were no changes reported by the manufacturer.)

PROFILE: ULTIMATE A1

Price as Tested = $50,645



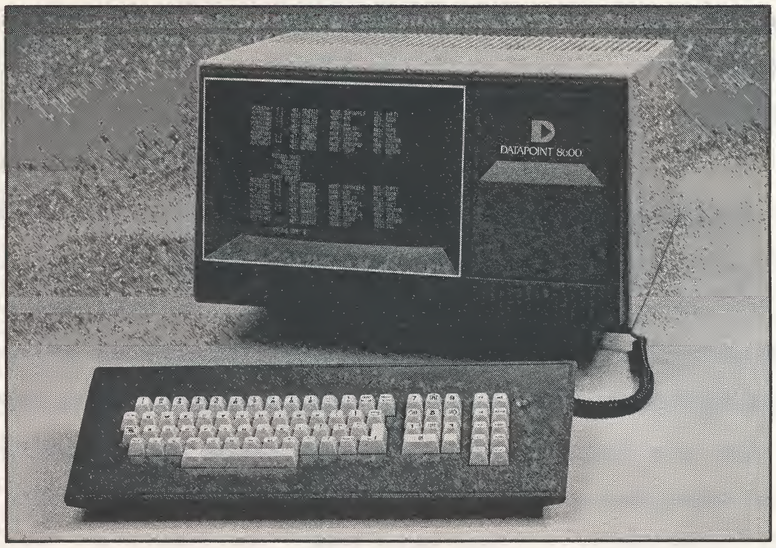
BEST FEATURES.....The Ultimate A1 is based on the same operating system as the Microdata 4000 which was written by Pick Computer Works. Ultimate feels it has the advantage since they have implemented what they call Release 10 on Honeywell equipment. The A1 has microcoded firmware which allows optimization of the virtual memory and data base management orientation of the machine. The A1 has a maximum configuration of 256K main memory, 80/16 megabytes hard disk, and 7 terminals (or up to 2 megabytes central memory, 2 gigabytes (2,000 megabytes) hard disk and 128 terminals. Tape drives are also available for Ultimate systems.

DRAWBACKS.........Some of the drawbacks of the Ultimate, according to users, were Ultimate's weak documentation, minimal training, and unreliable equipment, especially peripherals. Some also felt the A1 was slow.

UPDATE: *As of March 1982, Honeywell service maintains all items Ultimate sells except GE printers. This should alleviate some problems users were having with service since, in many cases, they had to go to three different sources for service (Ultimate for software, Honeywell for hardware and vendors of peripherals). The price of Ultimate-label CRT's has increased by $455.*

PROFILE: DATAPOINT 8600

Price as Tested = $48,175



BEST FEATURES.....Datapoint is the acknowledged leader in local computer networking. The Attached Resource Computer (ARC) network provides system users with full distributed processing/ resource sharing capabilities. The Datapoint's modularity gives almost unlimited growth potential. Processors may be added anywhere more power is needed using a standard coaxial cable. The 8602 processor can support 100 megabytes of on-line storage. However, many processors may be used, each with potentially 100 megabytes of storage. A more powerful 8800 processor can support one gigabyte (1,000 megabytes) per processor. Datapoint languages, utilities and word processing program were generally well liked by the users.

DRAWBACKS.........One of the weaknesses of the Datapoint is their language DATABUS. It's an assembly-like language which is simple to use but it lacks almost standard enhancements like structured flow-of-control statements.

UPDATE: (There were no changes reported by the manufacturer.)

CONCLUSIONS

This series of BENCHMARK REPORTS has been designed to provide you with comparative information about a number of the major computer systems available for business and scientific applications. Each report has included technical information and observations on the three key components of any system--hardware, software, and support. Additionally, imbedded within the reports are a number of comments concerning how you should go about selecting a system, and what features you should look for in making comparative judgments.

While we can describe the key features and limitations of each system which can help you make better evaluations, we cannot make a final decision for you. The best system for you depends upon your own needs and priorities. We have, over the past year, recommended every one of these twelve systems to at least one client, because each system met certain user requirements.

We do not mean to imply that there are no differences among the systems. There are significant differences in terms of features, performance, and cost. You must choose the system that is right for you. No single system can be best for everyone and, in fact, no system is ideal for anyone. Since it is unlikely that any system you choose will have every feature you ever wanted at a price you can afford to pay, you must make trade-offs. The following three steps are guidelines you should follow for making a selection that will be best for you.

Step 1 - Identify your needs, both for improving the efficiency of your daily operations, and for information required to effectively manage your business.

Step 2 - Using the Request for Proposal (RFP) as the basis for communicating your needs to vendors, evaluate alternative system proposals and choose the system which maximizes performance at a price you can afford.

Step 3 - Manage the implementation of the system and participate fully in the detailed design, development, and installation process to insure the system you buy is the system you really need.

We hope, of course, that you have found this series useful, and will continue to refer to it over the years. While equipment changes, software becomes more professional and error free, and vendor policies change, much of the information in the reports will be applicable for making comparative judgments.

We do mean it when we say we have liked every machine tested in this series. They all have merit, or we wouldn't have wasted our time and yours in preparing a report and having you read it. No single system can provide all possible features desired by all users, especially for under $50,000. The differences among systems simply reflect the choices and trade-offs made by each vendor. We have reported as many facts about each system as possible. But we have also made comments about the systems based on our own perception of what a business needs. Read our comments, but judge them in terms of your own personal needs, and evaluate the systems in terms of their ability to satisfy your business requirements.

We could not have completed this series without the cooperation of the vendors whose equipment we have evaluated. We've learned a lot, had fun, and met some very nice people. Each one has been dedicated to providing the best computing possible. And so, to the vendors and their representatives with whom we have dealt, we give a simple thanks and wish you all the best.

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BENCHMARK REPORT

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